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The preliminary trial trip of the U. S. protected cruiser "New York" was very successful. In 12 fathoms of water she made an average speed of 19.95 nautical miles per hour; and in her sea-trial she made 20.57 nautical miles in the same time, and maintained 20.38 knots for four hours. The trial trip of the "New York" calls attention to the fact that of the two crack English warships of about the same rating, the "Blake" and the "Blenheim," the former is now on this coast, preparing to take part in the naval review. The two ships compare about as follows:

	"New York."	"Blake."
Displacement.....	8,150 tons	9,000 tons
Beam.....	65 ft.	65 ft.
Length.....	375 ft.	380½ ft.
Mean draft.....	25 ft. 7 ins.	23 ft. 3½ ins.
Indicated HP.....	16,500 HP.	14,525 HP.
Speed.....	20.38 knots	19.28 knots
Coal capacity.....	1,500 tons	1,800 tons
Total wt. of single fire.	1,948 lbs.	1,808 lbs.
Radius of action at 10 knots.....	13,000 miles	15,000 miles

An asphaltic-concrete material for floors is described in "Indian Engineering," under the name of "bastard asphalt flooring." It consists of a 6-in. layer of 1-in. broken stone boiled in tar, with an upper ½-in. layer of coarse gravel or small stone chips, and slaked lime (2 parts of the former to 1 part of the latter), boiled in a mixture of coal tar and pitch. Both layers to be rolled, and the upper one finished with a top dressing of sand ¼ in. thick, and again rolled. This description of flooring has been used for freight shed platforms, etc., and found to be durable and satisfactory when not exposed to the sun. For the floors of ordinary buildings a thickness of 3 ins. is sufficient. The tar must be well boiled.

The new magazine rifle invented by Lieut. H. K. White, U. S. Marine Corps, promises to be a formidable competitor to the Krag-Jorgensen rifle approved by the army board of experts. The White rifle is to be officially tested by the Army Magazine Board reconvened to examine rifles of American invention and now in session. This rifle, which weighs less than 9 lbs., may be used as a single loader or with a clip containing 5 or more cartridges. Its inventor claims that it perfectly meets all but one of the 16 exhaustive requirements made out by the small-arms experts of the Navy. The principal requirements are as follows: 1, To be used either as a magazine arm or single loader; 2, to load and fire from magazine with facility without being removed from the shoulder; 3, the center of gravity of the piece not to be materially changed as the magazine is emptied; 4, filling of the magazine to be positive, and in one motion with cartridges in or from original packages; 5, the pull to be double, like that of the German trigger; 6, the sear not to be employed as a bolt stop; 7, the breech mechanism to be free from screws; 8, the bolt to have a fixed head; 9, the number of springs to be reduced to a minimum; 10, the bolt to be susceptible of being dismounted and assembled without the use of tools.

The most serious railway accident of the week was a head collision on the Atlantic & Pacific R. R., at Exeter, N. M., March 23, the cause being misunderstanding or disregard of orders. Two men were killed.

A bridge accident at Lima, O., on the Chicago & Erie R. R., was noted in our issue of March 9. The accident was caused by the derailment of the train, and was not due primarily to the failure of the bridge. We are indebted to Mr. J. C. Moorhead, General Superintendent, for the following particulars: The bridge, which crossed the Ottawa River, had two iron spans, 75 ft. and 62 ft., the former being the one damaged. The structure was ten years old. A broken truck left the track 400 ft. from the bridge, and the derailed train knocked down the 75-ft. span. Nobody was killed or injured.

A 4-in. nickel-steel casemate armor plate was tested at Indian Head on March 18. Carpenter projectiles were used weighing 33 lbs., and containing 9½ lbs. of powder, discharged from a 4-in. rapid-fire gun, with velocities of 1,595 and 1,676 ft. secs. The plate passed the test; no cracks appearing from the point of impact to the edge. Some cast-shells made by the Taylor Iron Co., of High Bridge, were also tested by being fired from a 10-in. gun against a 10-in. plate. The first shot penetrated the plate completely without marked deformation. The second, fired at a lower velocity, penetrated the plate slightly and rebounded. The test indicated decided advance in the manufacture of cast-steel projectiles.

The railway casualties in the state of Pennsylvania, as reported for 1892 by the Secretary of Internal Affairs, were as follows: Passengers killed, 42; injured, 658. This is one killed out of every 3,335,871 passengers carried, and one injured out of every 213,055. Of employees, 495 were killed and 6,833 injured; and of other persons, 952 were killed and 1,329 injured. The total is 1,489 killed and 8,820 injured. Car-coupling accidents account for many deaths among the employees.

A wharf at Santa Monica, Cal., is being built by the Southern Pacific Co. for the purpose of permitting sea-going vessels to unload in 34 ft. of water. The unloading wharf will be 1,500 ft. long and 103 ft. wide, and the approach to this is by 3,100 ft. of creosoted pile double-track trestle. A coal-bunker of 8,200 tons capacity is also being built. The trestle approach is now completed, and work is being pushed on the remainder. When finished, the company will practically abandon its terminal at San Pedro, the former port for all sea shipments to Los Angeles and vicinity. The railway company alone uses about 30,000 tons of coal per month, west of El Paso and Ogden, which is brought from British Columbia, Washington and Australia.

The forgings for the first nickel-steel gun ever made have been completed by the Bethlehem Iron Works, and are being assembled at the naval gunshops at Washington. The gun will be an 8-in. rifle, 25 ft. in length and will weigh 31,300 lbs. The steel contains about 3% of nickel. The tube of the gun has a tensile strength of 85,000 lbs., elastic limit of 42,000 lbs., and 20% elongation. The trunnion band has 90,000 lbs. tensile strength, 45,000 lbs. elastic limit and 13% elongation.

The color of the ships of the U. S. Navy has been under discussion by the Navy Department, and white as the color for painting these vessels is to be abandoned, as it becomes soiled and grimy very quickly, and makes the vessels too conspicuous in the night. A return to the black in which they were formerly painted will probably be made. The torpedo boat "Cushing," which is painted slate color or gray, is to be painted a dark bottle-green as an experiment; as it is claimed that this color gives the greatest pproach to invisibility by night.

The second-class passenger accommodation and fares are being steadily, though slowly, abandoned by English railways, as noted in our issue of Dec. 29, 1892. The Cambrian Railway has now followed the example of about ten other lines, as its second-class receipts have been decreasing for some time. This railway has about 237 miles of track.

A patented support for the tarpaulin covers used to protect the contents of open freight cars on English railways has been adopted by the North British Ry., after extensive experiments. The device consists of a movable wooden bar, traversing the whole length of the car along the middle, and standing two or three feet above the top of body, being held in position by a very simple arrangement at each end. On this bar is suspended the tarpaulin, which slopes down to the sides of the car. When not in use, it is easily swung out of the way, and made to rest on and flush with the top of side rail, thus obviating any interference with the processes of loading and unloading. The "Railway News" says: "When it is remembered that the tarpaulin thrown across a wagon in the old way is not proof against the rain, which gathers in pools on its unequal surface, damaging the goods, and giving rise to innumerable claims, the matter may be worth the attention of all railway companies." A more effective solution for the question of avoiding damage to freight by the weather would be a more general used of closed or box cars for damageable freight, but such cars, however, are comparatively little used in English railway service, except for such perishable freight as salt.

The North American Canal Co. is asking for incorporation from the Dominion Parliament. The chief promoter is Mr. Chauncey Dutton, of Pittsburg, Pa., who is associated with Canadian capitalists. The capital stock is to be $10,000,000, and the object of the company is to build a wide, deep canal from Lake Erie to the seaboard, via Niagara River, Lake Ontario, the St. Lawrence River, Cornwall Canal, Lake St. Louis and Lachine Canal to Montreal. A canal from Lake Champlain to tidewater on the Hudson is also part of the project.

The English style of compartment car is generally used in the British colonies, with the exception of Canada (which uses the American style of car, exclusively), but a better arrangement is desired in Australia, and experiments have been made with corridor cars. The Railway Commissioners of Victoria have been so satisfied with a plan which has been recently adopted for converting ordinary first-class cars into corridor cars for country lines, that they have determined to apply the system to second-class cars. By means of the corridor arrangement, smoking compartments, lavatories, and other conveniences can be provided for the whole of the passengers occupying each car. The second-class corridor cars will be made up from the better pattern of second-class cars now in service, in order that the different compartments may be as roomy as possible. For the carriage of fish, the commissioners have just had four cars fitted up on the Taylor cool solution system, and these are to be supplemented by 100 ventilated cars.

The railway car ferry across Lake Michigan has proved a success, and, according to a published statement by Mr. J. M. Ashley, Jr., Vice-President of the Toledo, Ann Arbor & Northern Michigan R. R., that company is about to let a contract for two more large steamers for the transportation of cars across Lake Michigan. It has been fully demonstrated that freight cars can be transported across the lake in the heaviest kind of weather. The new boats will be larger, faster and more powerful than the present ones, and they will be able to carry not less than 35 cars at one time. The present boats will each carry from 26 to 28 cars.

The switchback system of operation, as applied to ordinary railway service, is naturally little known in England, but is in use on a line in operation at Penwylh, near Neath, South Wales, called the Penwylh Mountain Ry. It starts from the Midland Ry. station, 1,108 ft. above the sea, and ascends by a series of switchbacks, or "zigzags," up the mountain to an altitude of 1,550 ft. The gage is 4 ft. 8½ ins. It is worked by an ordinary locomotive, which brings down about 40 tons at a time of limestone or silica sand, for furnaces in the district. The grade is 1 in 25, or 4%.

The New York Dock Commissioners have approved of a plan calling for the expenditure of about $11,000,000 in acquiring property along the river front, and in building 19 new ocean steamship piers, besides other piers, new bulkhead walls, etc. The commissioners estimate an income of about $807,000 per year from the completed improvements. The plans are made by Chief Engineer George S. Greene, Jr.

The Lefevre-Bremmer dynamite shell was tested near Syracuse, N. Y., on March 23, under Capt. T. F. Jewell, U. S. N. The shell has a casing of forged steel, is a little smaller in diameter than the bore of the gun, and between the casing and the cap, lying on the powder, is a felt buffer several inches thick. Within this casing is the shell proper, resting on springs attached to the end caps, and within this shell again is another shell of wood containing the nitro-glycerine, dynamite or other high explosive used. Nine shells were fired at a mass of rock 175 yds. from the muzzle of the gun. The press item fails to give the size of shell or weight of dynamite, but says that the shells exploded upon contact with a loud report, and broke off great masses of the rock and hurled them to a great distance.

The Northeastern Elevated Railway, in Philadelphia, has been commenced at Front and Arch Sts. Mr. C. W. Buchholz is president, and Mr. L. M. Haupt is engineer in chief, with James J. Ryan as contractor.

THE 5,000-HP. TURBINES FOR THE NIAGARA POWER PLANT.

(With inset.)

From time to time in these columns our readers have been informed of the progress of the great enterprise which is being pushed to completion at Niagara Falls, whose object is the utilization of Nature's most wonderful display of force "for the use and convenience of man." In our issue of Jan. 23, 1892, Mr. Clemens Herschel, Consulting Engineer of the Cataract Construction Co., gave an interesting summary of the work done up to that time, and the plans then in favor for the utilization of the power. This, it will be remembered, is made available by a canal taking water from the river above the falls and delivering it to a wheel pit at a convenient distance from the river. The waste water from the wheel pit flows to the river below the falls through a tail race tunnel.

We show on our inset sheet this week the working drawings of the 5,000-HP. turbines designed for the Cataract Construction Co. by Messrs. Faesch & Piccard, of Geneva, Switzerland, three of which are being built by the I. P. Morris Co., of Philadelphia. The drawings are reproduced from London "Engineering."

We may well preface the description of the turbine by a statement of the conditions under which the designs were prepared. The magnitude of the problems presented in the utilization and transmission of the enormous power available at Niagara led the officers of the Cataract Construction Co. to form an international commission of engineers, consisting of Sir William Thomson and Prof. W. C. Unwin, of England; Prof. E. Mascart, of France; Col. Theo. Turrettini, of Switzerland, and Prof. Coleman Sellers, of the United States. This commission was instructed to ask for competitive plans from the best engineering firms of the world for the development, transmission and distribution of this great power. The following were the firms which submitted plans in the competition; Cuenod, Sautter & Co., and Faesch & Piccard, Geneva, Switzerland; Escher Wyss & Co., Zurich; Ganz & Co., Budapest; Popp & Riedler, Hillairet & Bouvier, Riedler & Co., Vigreux & Feray, France; H. D. Pearsall, Geo. Forbes, Lupton & Sturgeon, England; Pelton Water Wheel Co., Norwalk Iron Works, United States.

The two United States firms proposed to utilize Pelton wheels to develop the power. All the other competitors except Mr. H. D. Pearsall proposed turbines of various types. Mr. Pearsall proposed his ingenious hydraulic air compressor, which acts on the principle of the hydraulic ram. We described and illustrated it in our issues of Sept. 28, 1889, and Sept. 22, 1892. Electric transmission of power was proposed by 7 of the 14 competitors. Of the others, 5 proposed compressed air transmission, 1 cable transmission, and 1 high pressure hydraulic transmission.

After examination of the designs transmitted, the commission withheld the first prize for hydraulic and electrical development combined, and awarded the second prize therefor of $2,500 to Faesch & Piccard and Cuenod, Sautter & Co., of Geneva, Four third prizes were awarded to Hillairet & Bouvier and Popp & Reidler, of Paris, and the two United States firms. Prizes for the methods proposed for power transmission were awarded to Ganz & C., and Lupton & Sturgeon, while the first prize for hydraulic development was awarded to Escher Wyss & Co.

The hydraulic development plans shown on our inset sheet are reproduced from the working drawings made by Messrs. Faesch & Piccard. Fig. 1 shows the general arrangement of the turbines, penstocks, governing apparatus and vertical shaft transmitting the power of the turbine to the surface. The turbine is set at the bottom of the shaft and works under a static head of 136 ft. The vertical pipe or penstock conducting the water from the canal on the surface to the wheel at the bottom is 7 ft. 6 ins. in diameter, and when the wheel is running at full power the water will pass down the penstock with a velocity of about 10 ft. per second. It is true that a considerably smaller penstock would answer, so far as the loss from friction is concerned; but with the larger penstock the energy stored in the falling column of water is less, and regulation of the speed of the turbine under changable load is less difficult.

The vertical shaft transmitting the power generated by the turbine to the surface is built up of steel plates forming a tube 38 ins. in diameter. The sections of this tube are connected by short sections of solid shafting, 11 ins. in diameter, and the bearings are placed on these solid sections. The weight of this vertical shaft, 136 ft. in length, with the turbine at its bottom and the dynamo attached to the top, is carried by the hydraulic pressure in the turbine itself, thus avoiding the complications and trouble attendant on the use of any of the ordinary forms of footstep. The vertical section of the turbine shows the construction of the balancing piston very well; it is located just above the upper set of blades.

The method of operation of the turbine is by no means so complicated as may appear at first glance. It is of the outward flow type; the water flows into it from the penstock and fills the central space surrounding the shaft. Its only escape is through the passages between the curved blades around the circumference of the wheel at the top and bottom. A partial section of these blades and of the escape passages surrounding them is shown on the plan view of the wheel.

It is well known that the method of regulation adopted is one of the most important features, as respects efficiency, in the design of a turbine. The system of regulation adopted here is throttling the flow of the escaping water from the wheel, a method which is exceedingly wasteful of power. To make this loss as small as possible the blades and guide passages in both the upper and lower turbines are divided into three sets by horizontal partitions, as shown in the vertical section. There are thus three rows of escape orifices, each orifice 4 ins. high and about 3 ins. wide. The valve by which these orifices are closed and the speed of the turbine is regulated is made in the form of a ring, surrounding the whole wheel and moved vertically by rods connected to the governing mechanism at the top of the shaft. The practical effect of this arrangement is that at either one-third or two-thirds load, the wheel is expected to work at the same efficiency as at full load. At any other load some one of the three sets of blades will be working more or less inefficiently, due to the loss of energy by the throttling of the escaping water.

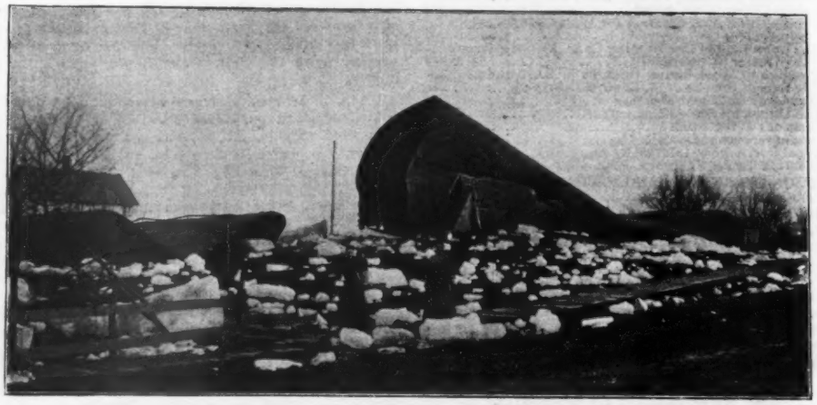
To somewhat equalize the load on the turbine and avoid changes in speed with sudden changes in load, the original plans provided for a 10-ton wrought iron flywheel to be placed on the vertical shaft a short distance above the turbine, and this flywheel is shown in our drawings. It was designed to have a circumferential speed of 11,000 ft. per minute. The addition of this wheel, however, is not yet decided upon, and will not be until the design of the dynamo to be fixed on the upper end of the turbine shaft is settled. If the rotating parts of this dynamo are sufficiently heavy, the flywheel in the shaft will be omitted.

The governing apparatus is located on the surface. It is of the centrifugal ball type, and has been patented by its designer, Messrs. Faesch & Piccard. Like all other hydraulic governers, the apparatus does not work the gates direct, but controls mechanism driven from the main shaft of the wheel, which raises or lowers the gates as required. It is claimed that with the arrangement shown the variation in speed can be kept within a maximum range of ½% with gradual changes in load, and that an instantaneous increase or decrease of the load of 25% will cause only 3% variation in the speed.

THE STAND-PIPE FAILURE AT MARYVILLE, MO.

A steel stand-pipe 18½ ft. in diameter and 135 ft. high fell at Maryville, Mo., on Feb. 28, 1893, as noted in our issue of March 9. We are indebted to Mr. J. M. Howells, of Chicago, consulting engineer, for the accompanying view and information:

The lower 50 ft. of the stand-pipe was split vertically from the bottom upward, and whirled out of place by the outgoing water, tearing itself loose from the foundation, and finally from the upper portion. This lower part was thrown a distance of 100 ft., but the upper 85 ft. dropped almost vertically onto the foundation, and then fell to one side.



STAND-PIPE FAILURE AT MARYVILLE, MO.

The failure was undoubtedly caused by ice within the pipe, but in what manner is unknown. At the time of the failure no water was being pumped into the pipe. The pipe was lined with ice from top to bottom, the ice having been 2½ ft. thick at the bottom and 4 ft. thick near the top, where the water level was especially liable to change.

The night previous to the failure the thermometer fell to 8° F. The failure occurred at 12:10 m., when it is said that the streets were muddy. This rise of from 40 to 50° in the temperature within a few hours may have had something to do with the failure.

The stand-pipe will be replaced by an elevated tank inclosed in a brick tower, so as to give an air space between it and the tower walls. The tank will be 18½ ft. in diameter and 50 ft. in height, with its bottom resting on a masonry tower 85 ft. high, thus giving, practically, the old stand-pipe with its lower 85 ft. cut out and replaced by a tower.

TESTS OF CAR COUPLERS.

The committee appointed by the Master Car Builders' Association to report further on specifications for couplers of the M. C. B. type, has obtained permission to make tensile tests of automatic couplers at the Watertown Arsenal, in Massachusetts. Drop tests will be made at Altoona, Pa. The committee therefore requests that owners of couplers of the M. C. B. type who desire to have their product tested by this committee should deliver free of charge eight couplers at Watertown Arsenal and four couplers at Altoona, Pa., as soon as possible. The couplers sent to Watertown Arsenal should be shipped to the "Commanding Officer, Watertown Arsenal, Boston, Mass," and the couplers sent to Altoona should be shipped to "J. M. Wallis, Altoona, Pa."; each coupler to be complete and ready for service, and to be marked for identification.

Communications in respect to the tests and advices of all shipments should be addressed to J. M. Wallis, Supt. M. P., Pennsylvania R. R. Co., Altoona, Pa., who is chairman of the committee.

THE NEW PALISADES TUNNEL.

We illustrate in the accompanying cuts the general plan and profile and the normal cross-sections of the double-track railway tunnel now being built through the Palisades, opposite New York city, and about two miles north of the Weehawken Tunnel of the West Shore R. R. As will be seen upon examining the topography of the west shore of the Hudson River there is a ridge of high land bordering the river, which begins as a range of low hills in the long tongue of land west of New York Bay, and gradually increases in height toward the north until it forms the precipitous bluff from 100 ft. to 500 ft. high, known as the Palisades of the Hudson River, and finally terminates in the broken highlands approaching the Catskill Mountains. All the railways which reach New York city through New Jersey have found a formidable barrier in this ridge, and when the height prevented an open cut have been obliged to resort to tunneling to reach the river front. There are now three of these tunnels, used respectively by the New York, Lake Erie & Western, the Delaware, Lackawanna & Western and the West Shore railways. The two first mentioned of these are quite close together, having their western termini but a few yards apart, and their eastern termini on the flats southwest of Hoboken and about one-half a mile apart. The third tunnel was built by the West Shore R. R. about ten years ago (Eng. News, June 17, 1882) and is farther north, being about opposite Fifty-sixth St., New York. The character of the material penetrated by this tunnel more nearly approaches that of the tunnel now being excavated about two miles farther north than does that of the others.

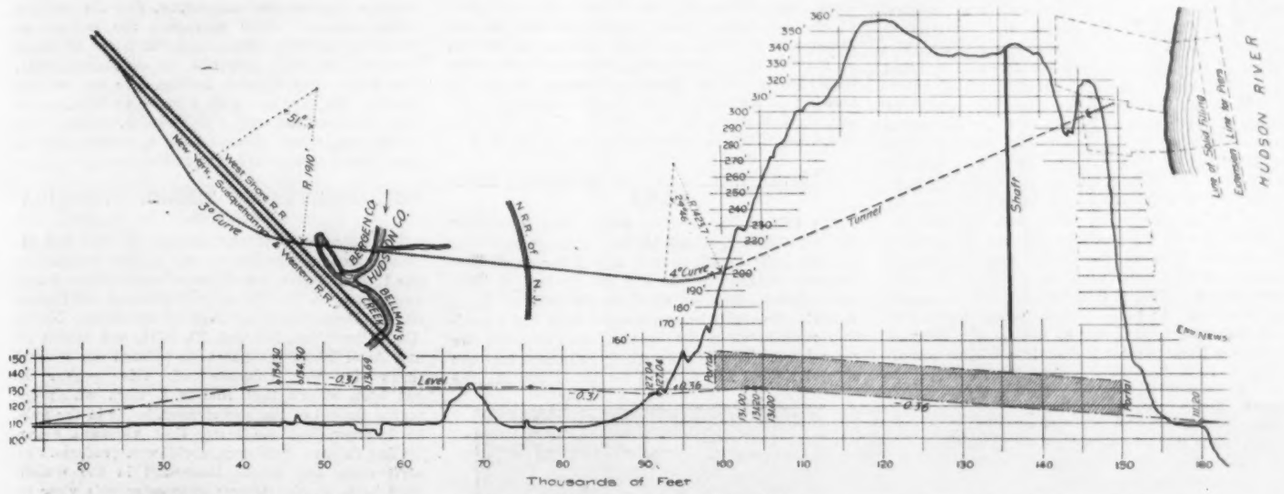


FIG. 1. MAP AND PROFILE OF THE RAILWAY TUNNEL THROUGH THE PALISADES; HUDSON RIVER R. R. & TERMINAL CO.

J. L. Ruslin, Chief Engineer; Broadhead & Hickey, Contractors.

This new tunnel is being built by the Hudson R. R. & Terminal Co., incorporated in the spring of 1892. In addition to the tunnel the work comprises the construction of about two miles of railway and large terminals on the Hudson River front. While all work is being carried on by the above named company rumor has connected the enterprise with both the Canadian Pacific and Pennsylvania companies (Eng. News, Nov. 17, 1892). Thus far, however, this is nothing but rumor, although external evidence and the facts, as far as known, support the supposition that some of the large railways approaching New York from the West are the real backers of the scheme. The facts known are that the Hudson River R. R. & Terminal Co. filed its charter in New Jersey on March 31, 1892, with an authorized capital stock of $2,000,000, the names of the incorporators being those of men of local reputation only. Of the authorized capital stock only about $7,000 were subscribed by the incorporators, whose names were given, leaving $1,993,000 of stock unsubscribed, or owned by persons whose names were not brought forward in the organization. Whatever the true inwardness of affairs may be this company has been pushing work since August, 1892, and is now making rapid progress in the excavation of the tunnel.

The general plan and profile of the railway and tunnel are shown in Fig. 1. The railway begins at a point on the New York, Susquehanna & Western R. R., about 1½ miles south of Little Ferry Station and about a mile from the village of Fair View, N. J. As will be seen from the map the line follows along the Hackensack Meadows, west of the New York, Susquehanna & Western R. R., and West Shore railroad tracks for a short distance and then swings east and south, crossing these roads and the Northern R. R. of New Jersey and entering the Palisades. The crossing of the West Shore and New York, Susquehanna & Western tracks is made on two overhead, pin-connected truss, skew spans of 115 ft. 6 ins. each, and that of the Northern R. R. of New Jersey on an overhead plate girder span of 80 ft. The foundation work for both bridges will be first class masonry. Some grading has been done on this portion of the line, and work well advanced on the masonry for the two-span bridge. A locomotive and 50 cars, with ballast unloader, are now engaged in hauling material from Paterson, N. J., for the fill across the meadows, and work will soon be resumed on the masonry. This part of the work possesses nothing worthy of especial mention.

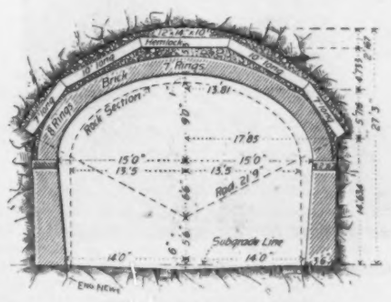


Fig. 2. Typical Cross-Sections of Palisades Tunnel

The principal interest attaches to the tunnel which is being excavated under the Palisades. In brief, this tunnel is 5,070 ft. long, and is to provide for two standard gage railway tracks. The typical section in solid rock is 27 ft. wide by 21 ft. high at the center, the roof being an ellipse, with a rise of 9 ft. The masonry section, which will be used where the rock is not self-supporting, will be somewhat larger, having widths at the subgrade line of 28 ft., and at the springing lines of 30 ft. The roof will be an ellipse with a rise of 10 ft. All masonry will be of brick. The several other dimensions of both the rock and masonry sections are shown in Fig. 2. The profile of the tunnel is shown in Fig. 1. As will be seen, the roof grade is continuous, descending from the west toward the river. The floor grade, however, changes at a point about 500 ft. from the west portal; rising by a 3.6% grade to that point, and then descending toward the river on a 3.6% grade. The material penetrated is the well known trap rock of the Palisades.

Work upon the approaches was begun about the same time at both ends, two portal shafts being started Aug. 1, 1892. At the east, or river end, the rock first encountered was unsound, detached in huge blocks, and full of seams, and it was found necessary to resort to an open cut, which was carried into the ridge until it became 80 ft. deep before the tunnel was begun. This did not end the trouble, however, for it was found that a large mass of rock directly above the tunnel section was detached from the rock on each side and was supported only by the rock below it, which was to be taken out in excavating the tunnel. It was necessary, therefore, to support this rock by timbering, and as it was impossible to excavate a heading the full width of the tunnel with safety from the face of the rock into the ridge, it was decided to work in the opposite direction. To do this an 8 ft. × 10 ft. drift was carried into the ridge about 50 ft., until sound material was found, and then the drift enlarged to the full width of the heading, working back toward the face of the rock with great caution, and supporting the roof with timber. A view of the portal after the completion of the timbering is shown in Fig. 3. About 60 ft. of the tunnel at the east end is timbered, and the section enlarged for the brick masonry lining. This section, which is 30 ft. wide and 22 ft. high, decreases to the normal rock section about 100 ft. in from the portal. Owing to the delay caused by this extra work the progress of excavation has been somewhat slower at the east end than at the west end, 390 ft. and 440 ft., respectively being excavated to date. At the west end the approach to the tunnel when completed will be an open cut 650 ft. long. The rock at this end was found to be good for a distance of 125 ft., and then became unsound and required timbering for a distance of 105 ft. The work is now being carried on in sound rock. In addition to the work on the two ends a shaft, 8 ft. × 16 ft., inside the timbering, has been sunk 180 ft., or to within 40 ft. of the tunnel grade. This shaft is located about one-fourth of the distance between the portals west of the east portal. It is intended to sink two or three more shafts, but no work has yet been done on them.

The tunnel is being driven by a top heading 7 ft. high and 18 ft. wide, which is afterward enlarged to the full width of the section. The plan of operation is to drive 24 8-ft. holes in the heading for each firing. Eight center holes and two side rounds of eight holes each are drilled and fired in three separate blasts, the center being fired first.

For removing the bench two rounds of holes, top and bottom, are drilled, and often extra holes to break the rock to grade. The material penetrated is a very hard trap rock, containing occasional veins of calcite carrying iron pyrites, and is full of cleavage seams. Rand and Ingersol drills are used, about 26 being now in operation in the two ends and the shaft, with 1¾ ins. steel and 2½ ins. bit, and 30 ft. for each drill in a shift of ten hours is considered good work. From 12 to 14 tons of high explosive, containing 60% nitro-glycerine, are used each month. The rock breaks quite heavy in the bench, and an especially designed derrick car is used to handle it without further breaking. This car runs on a center track, the mucking cars running on tracks at each side, and is so designed that the weights of the engine and car balance the derrick and its load without any guying. The bodies of the mucking cars are capable of being removed from the trucks. The method of operation is to lift the car bodies from the trucks by means of the derrick and place them on the tunnel bottom, close up to the bench, and when filled to replace them on their trucks. By this means the car bodies are placed low down, enabling large stones, which could not easily be lifted except by power, to be rolled into them, and are also situated so that by an overhead staging the barrows of material brought from the heading can be dumped directly into them. In addition to handling the car bodies, the derrick is used to handle heavy stones. At present horse power is used to haul the mucking cars, but as soon as the distance becomes a little greater locomotives will be substituted.

FIG. 3. VIEW OF EAST PORTAL HEADING, PALISADES TUNNEL.

The plant used in carrying on the work is unusually large, and is situated at the west end of the tunnel. Briefly, it consists of eight 100-HP. boilers, furnishing steam for four Rand duplex, 18 × 32-in. air compressors, and an engine running a 30-arc. light dynamo. The compressed air is carried over the ridge by pipes varying from 10 ins. to 5 ins. in diameter to the shaft, and also the east end, where it is used in running the hoisting engines and to work the bellows in the blacksmith shop. Electricity for lights, which, it should be stated, are used for the work, both inside and outside of the tunnel, is also carried by wires to the east end. The buildings at the west end are connected with the Northern R. R. of New Jersey by a switch for bringing in coal and material. In addition to the above stationary plant, the contractors have 3 locomotives, 106 cars, 5 portable boilers, 7 hoisting engines, 15 derricks, 2 derrick cars, 40 carts, 6 wagons and 45 head of horses on the ground. There are now 482 men at work.

At the eastern terminus of the tunnel, which is about opposite 110th St., New York, the company have a river frontage of about 1,500 ft., with an average width available for yard purpose of 1,300 ft.; in all, a tract of about 45 acres. Work is now in progress excavating and filling preparatory to putting in the necessary tracks and other terminal facilities.

The contractors are Messrs. Broadhead & Hickey, who built the Vosburg Tunnel, 3,900 ft. long, on the Lehigh Valley R. R. in Wyoming County, Pa., and have had large experience in heavy railway construction, and especially tunnel work. Mr. Calvin E. Broadhead, M. Am. Soc. C. E., had charge of the engineering work on the Musconetcong Tunnel, on the Easton & Amboy R. R., and Mr. Hickey's experience dates from the construction of the Hoosac Tunnel. Mr. J. L. Rusling, of Paterson, N. J., is Chief Engineer, and Mr. E. S. Safford, M. Am. Soc. C. E., is Resident Engineer, with headquarters at Fair View, N. J.

INCLINED RAILWAY AT BRISTOL, ENGLAND.

The Clifton Rocks Ry., which was opened at Bristol, England, March 11, is a steep grade incline railway built to afford easy access for passengers between districts at the top and bottom of cliffs about 240 ft. high, as noted in our issue of April 4, 1891. The cliffs have a vertical face, and a roadway runs between the base of the cliffs and the river Avon. The line is entirely in tunnel, and has a total rise of 230 ft. in a length of 500 ft., the grade being 45.83%, or 1 in 2.182. The tunnel is 27 ft. 6 ins. wide and 18 ft. high, with four tracks. It was originally intended to have three ventilating shafts and not to use a masonry lining, but these plans may have been changed, as much difficulty has been encountered in driving through loose shale beds, which caused several bad falls, and it was difficult to keep the men at work, so that the line has taken two years to build. The tunnel is said to be lighted by gas, although electricity was first proposed, and there are also lamps in the cars. Each pair of cars is connected by a wire cable passing over a drum at the summit, and the descent is effected by filling the water tank of the upper car so as to overbalance the lower car. The brakes and safety stop appliances are said to be very complete and of a pattern designed by Mr. Marks, one of the engineers. The track brakes, gripping the rails, are automatic, and must be held out of gear by both conductors during the trip, or the cars will be stopped. A speed governor and emergency brake are also provided. The engineers were Mr. Phillip Munro and Mr. G. C. Marks.

The carrying capacity is given as 1,000 passengers per hour, and on the opening day 6,220 passengers were carried. The fares are 4 cts. for the up and 2 cts. for the down trip, and through tickets will be issued by the street railway which passes the lower station.

Several short, steep-grade inclined railways on this plan are in operation in Switzerland, and in England there are four besides the new Bristol line, but the latter is, we believe, the only four-track line, and all of them are for passengers only, and not for vehicles and teams, like the inclined cable railways which surmount the heights of Pittsburg and Cincinnati, and which are of heavy construction, with powerful winding machinery. The other four English inclines are as follows: Lynton, 900 ft. long, with a grade of 57.8% (1 in 73); Scarborough, 50%; Folkestone, 47.6%, and Bridgnorth (Eng. News, Aug. 4, 1892), 120 ft. long, 66.6% grade, 111 ft. vertical rise.

THE GOVERNMENT TIMBER INVESTIGATIONS.

The importance of the systematic tests and investigations of the timber and timber supplies of the United States, which have been instituted and commenced by the Forestry Division of the United States Department of Agriculture (Eng. News, Aug. 8 and Nov. 28; Oct. 10, 1891, and March 12 and April 16, 1892), has been pointed out several times in the columns of this paper. It has been shown that this is a work which deserves the aid of the government, being in the public interest, but we learn that although many leading railway engineers, architects, professors of engineering and others interested in the timber tests have written letters expressing this view to their representatives and senators and to the committee on manufacturing, in whose hands the special appropriation for the work was pigeonholed, neither the committee nor the House paid any attention to this expression of public interest. The Senate, however, realized that there was value in the work, and sincerity in its indorsers, and increased the appropriations for the Forestry Division by $8,000, and that is 20% of the amount asked and considered by those in charge as necessary to continue the work on a proper business basis. Under these circumstances, the testing will be discontinued until after July, when the new appropriations will become available, and then proceed at the slow pace which Congress has set. While the result of the efforts of those who took active interest in securing appropriations for the work were not crowned with that success which they deserved, this is the only proper method of influencing legislation, and those interested in the investigation should not fail to move again when the new Congress assembles.

The first compilation of test results is now in the hands of the printer, and will probably be issued in a few weeks as Bulletin No. 8, Timber Physics, Part II. It will contain the results obtained on longleaf pine, and will especially discuss in detail the results of tests and examinations of bled and unbled timber, results which in themselves justify the expenditure by the government of money on such work. Part I. was issued several months ago. At the World's Columbian Exposition the Forestry Division will exhibit the methods pursued in this work, which will be of interest, since nowhere in the world has such comprehensive and systematic investigation of timbers been ever devised. The working plans for a similar undertaking by the Prussian government have only just been perfected. Another exhibit of interest to railway engineers and those interested in reducing forest waste will be a collection of the most approved types of metal railway ties used throughout the world, and a complete set of colored drawings illustrating the various forms of metal ties now in use, being copies of the original drawings from which the plates were made for the report on "The Use of Metal Railway Ties," made to the United States Government by Mr. E. E. Russell Tratman in 1890 (Eng. News, Aug. 30, 1890, and Aug. 15, 1891). This report showed that, excluding the United States and Canada,

which have no extent of metal track, over 13% of the railway mileage of the world is laid with metal track. The exhibit will also include metal tie-plates, which are an important addition to railway track equipment.

AN ELECTRIC CAR TRIAL.

By Dr. Frederick Bedell.

The severe demands made upon the electric car motor, and the sudden fluctuations in the flow of current, and in the power developed, have been frequently discussed, and have often been illustrated by curves showing the performance of the car motors. The accompanying curves show the results of a trial made in Rochester by Mr. J. L. Hall and the writer, and is given as further evidence of the severe character of the service.

The car was tested under normal working conditions while making a regular passenger trip in the middle of an afternoon when the track was in good condition. The passengers in the car kept changing from 4 to 24, averaging about 12. The test was made upon a vestibuled car, built by the Gilbert Car Mfg. Co., of Troy, N. Y., having a length of body of 18 ft. and a wheel base of 6.5 ft.

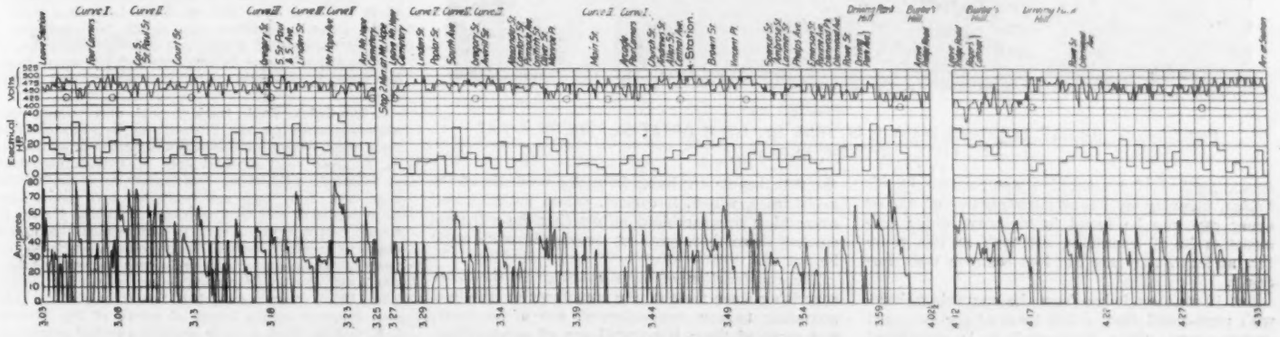
In general the route is quite free from grades, the heaviest being a grade of 4% at Burke's Hill.

Some of the results of the test are as follows:

	Amperes. Mean.	Amperes. Maximum.	Electrical horse power. Mean.	Electrical horse power. Maximum. Momentary.	Electrical horse power. Maximum. For ½ min.
Station to Mt. Hope.	28.06	81	17.3	50	40
Mt. Hope to station.	15.41	70	9.5	43.2	31
Station to Ridge Rd.	21.19	82	13.1	50.7	34
Ridge Rd. to Station.	22.36	60	13.8	37.1	31
Average	21.94		13.5		

By an independent run the tractive force on a level road was found to be about 1.9% of the weight of the car.

The above results and curves clearly illustrate the character of the demands of electric traction under normal working conditions.



TESTS OF AN ELECTRIC STREET CAR AT ROCHESTER, N. Y.; By Dr. F. Bedell.

It has two 15-HP. Short double-reduction motors, with 6-in. gears on the armature and intermediate shafts, made quite noiseless by wooden webs. The reduction ratio is 1 to 10.4. The current passes from the trolley to a hood-swich at each end of the car, then through a fuse-box to the rheostat, which has 13 sections, with a total resistance of 13 ohms, and is cut out a large part of the time. From the rheostat the current divides to the two motors, passing first through the armatures, then through the fields and to the ground. The total weight of the car was 16,120 lbs.

During the run the total current supplied the car was measured by a Weston ammeter, and the potential difference at the motor by a Weston voltmeter, the instruments being simultaneously read every five seconds and the results recorded. The advantages obtained by reading from these instruments in this way rather than employing self-recording instruments are two: First, the aluminum needle and the suspension in these instruments are lighter and their accuracy is accordingly less affected by the inertia of the moving parts. Second, in calculating the horse power from the results, it is necessary to integrate the curve for current and potential, which may be done by this method by averaging the five-second readings, whereas, in case a self-registering device is employed, the curves must be gone over with a planimeter, and experience shows that the integration of the blurred and confused curves which result is far from satisfactory. On the other hand, the curves thus obtained from five-second readings lose some of the minor variations. However, that the mean final result is not materially affected thereby is seen when we consider that in an hour's run the horsepower is calculated from a mean of 1,440 readings.

The accompanying curves speak for themselves. The upper curve shows the potential supplied to the motors; the lower curve the total current taken; the middle curve, the electrical horsepower averaged for half-minute intervals. The location of feeders is indicated by circles. The five curves in the route are as follows, the radius being measured to the center of the track:

No. of curve.	I.	II.	III.	IV.	V.
Length.....	90°	90°	40°	103°	90°
Radius, ft.....	50.5	50	90	40	80

THE GRAPHICAL METHOD OF SOLVING ENGINEERING PROBLEMS.*

There is a considerably increasing use being made of graphic methods in engineering text-books and journals, and this method has peculiar advantages, both for solving problems and representing facts. A very large proportion of graphical statements take the character of either cartesian (sometimes called linear) diagrams, or of polar diagrams, and there are a number of different kinds of instruments which automatically record graphical statements. These graphical statements, given by plotted or automatically-recorded curves, are nothing more than graphical tables of numerical results, which have the great advantage of exhibiting at a glance the general nature of the facts, and taking a practically unlimited number of points on such a continuous curve, and may be regarded as merely substitutions for tabulated results.

Various text-books and pocket-books use plotted curves for representing the proportions of valves, the proportions of belts, ropes, screw propellers, boilers, the teeth of wheels, girders, pipes, bolts, coal consumption, etc., and there are also plotted statements for numerical calculation, such as the "abacus" of Lalanne. There is a class of graphical statements which do not take the form of a continuous curve, examples of which must be familiar to every engineer in the form of diagrams which represent the forces acting in various members of a roof truss or bridge. Here we find the number of lines often forming figures of great complexity, which obviously do not lie under the head of either polar or linear graphic statements of two variable quantities. The fact is that these drawings are merely a compromise of the nature previously alluded to, in which it is convenient to represent magnitudes of three variable quantities; and, in addition, the position in the frame or truss at which forces act the parts of the structures in question. It is a mere accident that these diagrams form a figure in which the lines do not cross so as to produce hopeless confusion. As long as they do not do this there is, of course, no limit to the number of lines which can be drawn, and therefore to the number of membership on the frame structure, the forces in which may be studied by means of such a graphical statement.

The next point to be considered is the graphical modes of operation which correspond to arithmetical or algebraical operations. Just as we have in books of algebra chapters on various rules and processes—such as addition, multiplication, progression, permutations and combinations, logarithms, etc., so we may naturally look for graphical rules and processes which shall enable us to perform similar operations; and just as those various rules of algebra have been slowly discovered and collected, so as to form a harmonious whole, so we may look for a gradual collection of the more isolated graphical operations which have been and are being discovered by various workers in graphical methods. Thus we find in recent text-books on graphic statics, graphical addition, multiplication, the extraction of roots and powers are given, though beyond this nothing of a very satisfactory nature has been achieved, except that a few extremely valuable methods applicable to certain parts of mechanics have been discovered. Now, it must be borne in mind it does not follow that because a process can be performed graphically that therefore it will be worth while to use it, and it is here that the engineer will soon decide what is more convenient to do graphically and what is better to calculate numerically.

Coming next to the actual mode of graphical operation we may place first and foremost, in utility, simplicity, and frequency of employment, the method of "interpolation," which consists in finding from any graphical statement in the form of a continuous curve an intermediate value by drawing a line at the point required, as, for instance, to find the pressure in an indicator diagram at any given stroke. Now that modern or projective geometry, which deals not merely with surfaces, but with lines in space, has been directly applied—first by Culmann, and since by other writers—to the subject of graphical statics, there appears to be no limit to the number or variety of engineering problems which may be thus dealt with. What is wanted at the present time is a clearer understanding of the foundations of the subject, so as to collect and bring into a more definite system the rapidly growing number of problems and publications of all kinds which deal with graphical statements and operations.

* Abstract of a paper read March 8, by Prof. H. S. Hele-Shaw, M. Inst. C. E., before the Liverpool Engineering Society, England.

A Swan compressed hot-air pumping plant has been tested near Derbiay station, on the Union Pacific Railway, in Colorado. The scheme is to elevate a large volume of water to a moderate height, for irrigating purposes, and do this by means of compressed hot air acting directly upon the water surface. The test was conducted by Professor Carpenter, of the Colorado State Agricultural College. He reported, in the Denver "Sun," 6 cu. ft. of water per second were raised 24 ft. high through 250 ft. of 12-in. discharge pipe, with an expenditure of 150 lbs. of coal per hour. The flow was continuous, and the pump will handle muddy or gritty water.

The Commercial Cable Co., of New York, has voted to lay a third cable across the Atlantic. The report for 1892 shows: Gross earnings, $1,890,377, and net earnings $1,099,587. During the year $540,000 was disbursed for dividends, and $600,000 was appropriated for redemption of debenture bonds on Jan. 15, 1893.

The Geological Society of Washington, D. C., was organized on Feb. 23, 1893, and held its first meeting on March 8, with 108 members. The president is Mr. C. D. Walcott, and Messrs. Whitman Cross and J. S. Diller are the secretaries. There are active and corresponding members, the subscriptions being $2 and $1 per year. Meetings are to be held twice a month, from October to May, but for the present it will not publish its papers in a journal of its own.

Steel anchors are being made by the Penn Steel Foundry & Machine Co., of Chester, Pa., which have sustained very severe tests by government inspectors, and are to be used on some of the new U. S. naval vessels.

The total amount of material produced by the lumber and sawmills of California, Oregon and Washington in 1890, is given by Census Bulletin No. 304, as follows, the corresponding figures for 1890 also being given:

	1890.	1880.
Lumber, M. ft., B. M.....	1,946,168	642,142
Shingles, M.....	902,701	147,308
Staves, M.....	25,720	5,220
Sets of heading, M.....	1,030	1,200
Lath, M.....	27,215	*
Total mill products and manufactures	$27,499,981	8,194,981

* Not separately reported in 1880.

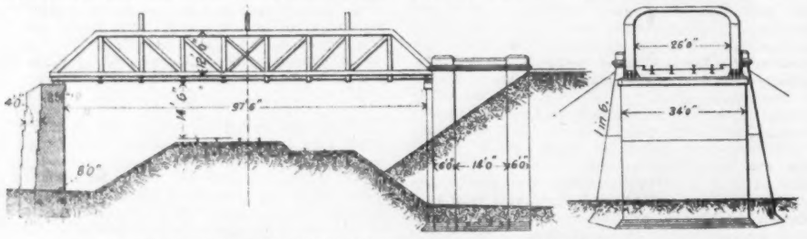
A SPECIMEN OF BRITISH BRIDGE CONSTRUCTION.

In our issue of Oct. 6, 1892, we illustrated a pony truss highway bridge at Strathglass, Scotland, which failed under a dead load of about 35 lbs. per sq. ft., by buckling of the top chord. Our readers who will refer to that number will see that the top chords of the riveted trusses, 130 ft. long, were connected by arched "stays" at intervals of 30 ft., each stay being made up of a $6 \times \frac{1}{2}$-in. plate and two $3 \times 8 \times \frac{5}{8}$-in. channels. We supposed this

PONY TRUSS BRIDGE CARRYING SAXBY & BOURNE RY. OVER GREAT NORTHERN RY. AT LITTLE BYTHAM, ENGLAND.

idiotic method of construction was peculiar to this bridge, knowing well that monstrosities of almost every sort can be found in highway bridge construction in all countries, although in this country, at least, they are far less common than formerly.

But if we may judge from the engravings herewith reproduced from a late issue of our esteemed contemporary, "The Engineer," it is considered good practice in England to build pony truss bridges



ELEVATION AND CROSS SECTION OF PONY TRUSS BRIDGE.

and connect their top chords by arched struts, without diagonal bracing, and not alone in highway work but in the construction of new bridges on a line of railway now being built by one of the largest companies in England.

We extract from our contemporary's columns the following description of the structure shown, which has been erected for the Saxby & Bourne Ry., an important though short line which the Midland Ry. Co. has nearly completed, over the Great Northern Ry., Mr. J. A. McDonald, M. Inst. C. E., being Chief Engineer.

> The Saxby & Bourne Ry. will form an important factor in the development of the traffic to and from the Eastern counties. . . . The only large iron bridge is over the Great Northern Ry., at Little Bytham. It has a clear span of 97 ft. 6 ins., and consists of two open truss main girders with cross girders and rail bearers, the cross girders being hung from the vertical members of the main girders. The flooring is formed of flat wrought iron plating. The total weight of iron work in the bridge is 152 tons, and was erected on a timber staging built over the Great Northern Ry. . . . . The railway has evidently been carefully laid out, and seems in every way capable of carrying a heavy through traffic. The work throughout is well done, and is of a most substantial character.

Doubtless there may be pony trusses 12 ft. high and of 100 ft. span on American railways, but we trust and believe that no such structures are being erected at the present day. All first-class railways in this country have practically discarded the pony truss, and have adopted the plate girder in its stead, the advantages of which are so familiar that they need not be recounted here. Such pony trusses as are erected in this country for railway bridges are made of moderate depth, and depend for their lateral stiffness on knee braces from the floor beams.

Whether there are any "mitigating features" in connection with the structure shown, such as extra size of members, or bracing which does not appear in the drawings, we do not know; but we hope for the sake of the travelers who may pass over the railway that there is a surplus of strength somewhere not apparent in the drawings. All the information given by our contemporary goes to discredit the structure. It states, for example, that the floor beams are hung from the verticals of the main truss, which, if correct, would indicate that everything was sacrificed to lowering the rail level so that those three precious overhead struts could be put on.

The construction of such a bridge is the more surprising since most of the structures on the line, according to our contemporary, are of masonry, and some of those illustrated are of excellent design and expensive construction. English engineers make extensive use of plate girders, and what led to the erection of this pony truss, with curved top struts, on such a road, to say nothing of its illustration as an example of good practice by a journal of "The Engineer's" standing, is a problem beyond our comprehension.

A BRITISH CRITICISM OF AN AMERICAN BRIDGE.

In our issue of Dec. 15 we quoted from "Engineering" the story of how American bridge companies bid on the bridges for the Transandine Ry., and not only beat their English competitors in price, but delivered the goods in one-fourth the time asked by the English firms. In the following issue of our contemporary appeared a virulent criticism of one of these bridges, of which the details were published—a 246-ft. span built by the Phoenix Bridge Co. A reply to this criticism is made in "Engineering" of Feb. 10 by Mr. Bonzano, of the Phoenix Bridge Co., and it is highly interesting to see how neatly and thoroughly he does up the anonymous critic. We reprint both the letters below for our readers' edification.

To the Editor of "Engineering," Sir: I have noticed this article in your issue of Dec. 2. From the description given therein of a 246-ft. span I feel surprised to find that such a rickety concern as this should be adopted by any engineer in these days of knowledge and experience in bridge building.

It will be interesting to learn what amount of lateral deflection takes place in it when a long train of high vehicles is passing over during a strong gale of wind blowing against its side (should it be left standing).

As to the question you ask, "How could American firms offer to build the bridge in as few weeks as the English firms required months?" the answer is correctly given: That their system of bridge building enabled it to be done. This, as a sample of the system explains it, and so also does the great Hawksbury Bridge in Australia, made so cheaply and expeditiously by an American firm, about which an interesting article as to its "peculiar behavior" or lateral movement appeared in your paper soon after it was in use.

A careful, responsible engineer will always design his own work in all its details; if he has no capable assistant he will call in the aid of an expert in the art of iron bridge building, and not place himself in the hands of the manufacturer, because he may offer to do something smart (i. e., cheap and quickly), but must, of course, be allowed to do it according to the templates he happens to have. Yours truly,

Expert of Forty Years' Experience.

Westminster, S. W., Dec. 5, 1892.

To the Editor of "Engineering," Sir: We make it a rule to take no notice of irresponsible anonymous letters, but the recent communication in your issue of Dec. 9, 1892, reflecting on the character of the work we furnished the Transandine Ry. in 1889, work which was awarded to us in open competition, after an examination of our plans and details by Messrs. J. E. and M. Clark & Co., of your city, we think demands a reply.

The letter in question can hardly be considered a shining example of a fair and dignified discussion of engineering problems by an "expert," yet we shall try and pick out points raised by this "expert" and answer same.

1. The 246-ft. single track through narrow gage span we constructed for the Transandine Ry. was designed for a wind pressure on unloaded structure of 40 lbs. per sq. ft. over total exposed area of trusses and floor, as shown in projection. For loaded structure, narrow gage cars, 8 ft. deep and beginning 3 ft. above rails were assumed, and as a pressure of 25 lbs. per sq. ft. would overturn these cars (a fact which the expert seems to have overlooked), this pressure on exposed surfaces of trusses, floor, and train over the entire bridge was used, the latter portion being considered moving load. Upon above assumptions the bracing of the span was designed with a factor of safety of 3½. Messrs. J. E. and M. Clark & Co.'s engineer checked over every figure of our strain sheet, and every detail of the design before the work was commenced in the shops. This engineer remained at the mills and shops during the construction, giving same careful inspection, and did not leave our works until every pound of the material was shipped. The structure was erected promptly in the field, fitting together without the least trouble, and has given entire satisfaction since being in use.

2. The Phoenix Bridge Co. were prepared to construct the bridge in accordance with plans and specifications in time named in their proposal. Why English manufacturers did not name as short a time, we at this distance do not attempt to answer.

3. The insinuations made against the Hawksbury bridge we leave to the Union Bridge Co. to make reply, as the builders of that important structure. That they are entirely competent to do this, being the designers and builders of some of the most important bridges in the United States, even the "expert," we believe, will admit.

4. If the experience gained by a business of over 30 years in the designing and construction of every style of iron and steel bridges, many of them the largest of their class at the time constructed, may be considered valuable, we feel that we are not presumptuous in calling ourselves experts in the art of iron bridge building, and that Messrs. Clark did not award their work to novices in the business, but, instead, had the benefit of not only one expert but several experts of many years' experience, members of the engineering staff of the Phoenix Bridge Co.

We trust that if the "Expert of 40 Years' Experience" feels obliged to again address the public through your valuable journal that he will have the manliness to sign his name to the communication.

We remain, yours very truly,

The Phoenix Bridge Co., by A. Bonzano,

V. P. and Chief Engineer.

Phoenixville, Pa., Jan. 11, 1893.

We hope if the "expert of 40 years' experience" is anxious to win further laurels in the way of criticism, he will make a careful study of the 100-ft. pony truss span just erected on an important English railway and described in another column, and will give out his opinion for publication.

A torpedo-boat, designed to attain a speed of 30 knots or 34½ miles per hour, is about to be undertaken by the firm of Augustin, Normand & Co., of Havre, France. The highest speed record for a torpedo-boat at present is a little under 29 miles per hour made by the "Arlete," an English built vessel.

COST OF LAYING WATER PIPE.

By C. D. Barstow.

During the autumn of 1892 it became necessary to add 10.9 miles to the water pipe system of a Southern city of 30,000 population. Work was begun Oct. 25, 1892, with the intention of completing it by Dec. 31, if possible, owing to the continuous rains usually prevailing after that date.

Special attention was given to keeping an accurate record of the time, its proper distribution to the different divisions, and the cost of the work; with the idea in view of obtaining data on the cost of such work in days and in dollars, which would be of interest and profit to any one making estimates of cost upon, or doing similar work in any part of the country.

There were two conditions prevailing here that would not exist in laying the mains of a new plant: (1) There were many short lines of pipe to be laid from one point to another upon the mains already in. This necessitated moving the entire force frequently, and thus increased the cost. (2) Every new main crossing an old one was connected with it by cutting out a piece of the old and inserting a cross or tee. This work was found to delay the regular pipe gang so much that a special force of five men made these connections in advance of the other work, leaving a valve to which the new main was easily connected. In some cases where the mean rate, including the men at different rates that were employed on each particular piece of work determined by division. The work done per day per man is somewhat less than would be expected in the North. Bearing this in mind, the figures giving days per foot can be used in any locality, substituting the prevailing wages of that locality for those used here.

The work may be divided into the following parts:

Excavating trench.
Laying pipe.
Filling trench.
Lead and hemp.
Miscellaneous items.

Excavating Trench.

Before beginning operations each street was examined and all conditions bearing upon the cost of the work were carefully noted, such as the size, depth and location of existing sewer, gas and water pipes, culverts, manholes and street car crossings, together with the difficulties that must be met and the general method to be followed in overcoming them. Test pits were sunk along the proposed pipe lines at intervals sufficiently frequent to leave no doubt as to the nature of the material that would be encountered in excavating. Profiles showing established grade on all ungraded streets were obtained, and the trench dug to such depth as never to require lowering.

The trench gang was in charge of one foreman. The number of men varied from 25 to 65. A blacksmith with portable forge was kept near the trench. He was paid $1.50 a day. A boy at 75 cts. per day helped him, and carried picks to and from the men. Sixty picks were dressed a day, besides doing other work that was necessary. Two-thirds of the picks were used by trenchmen, and one-third by bell-hole men. The smith's time was distributed in that proportion to trench and pipe-laying. Whenever men were needed by the pipe gang to keep the trench clear of caves or water they were taken from the trench gang and charged to trench. The following tables show how the cost of the trench is affected by the kind of earth excavated, the condition of the weather and the method of excavating.

Table I., A, includes 11,000 ft. of trench in the oldest and principal streets in the business part of the city, having a mean width of 2 ft. and a depth of 3½ ft. There were many places where in going under sewers and pipes the trench was 4 ft. and 5½ ft. deep. With the exception of one block, shown in Table II., none of the streets were paved. The original earth was a hard cemented clay and gravel, requiring much picking. Some parts of the streets were in this condition on the surface, some had been surfaced with broken stones and some with gravel. Occasionally a short section of cobble stone paving would be found, while in other places the street had been filled with large cobblestones to the full depth of the trench. There were a few places where the streets had been filled, and heavy rains caused the sides of the trench to cave, making the earth muddy and shoveling difficult. There were 700 ft. in soapstone, taken out with difficulty by picking; 350 ft. in rock that required blasting, which cost 24 cts. per ft.; 1,200 ft. were in ground containing springs, making the work very muddy. During the work there were two periods of rain, each of them thoroughly saturating the ground and filling the trench with water.

Table I., B, relates to 6,000 ft. of trench in bottom land, being a deposit of sand and loam, containing no clay or gravel. The surface was generally level. In one place the trench was 2 ft. deep and in two others 5 ft. deep, but it would average 3 ft. The streets had never been gravelled. Where the trench was in the traveled street, picking was necessary for 1 ft. below the surface. Beyond this depth the earth could be spaded. For about 1,500 ft. the trench was on the side of the street, and no picking was necessary. No rain occurred during the time this work was in progress. There was 39,423 ft. of trench in the residence portion of the city and away from the pipes, sewers and annoyances referred to above. The surface of the ground was undulating, the hills being made up of compact cemented clay and gravel. Some of the valleys had enough sand and soil mixed with the gravel to make the excavating somewhat less difficult; all of it, however, required picking from the surface down. Most of the streets were used enough to make the first foot in depth very hard. Some of the streets were not graded, and it was necessary to excavate 4, 5 and 6 ft. deep, and in other places only 2 ft. deep. While the shallow pipe crossed culverts or other obstructions, a few lengths would be laid by the five men, leaving one end of pipe on each side easily accessible for connection by a buckle or sleeve.

Colored labor was employed at $1.25 a day, a few, better than the rest, receiving $1.50. Water and horse boys were paid 50 to 75 cts. per day, and calkers, $1.50 to $2, according to their ability. In the tables following, the actual number of days and dollars are given, and the approximate

Table I.—Time and Cost of Excavating Trenches.

A. Including 11,000 ft. of Trench in the Oldest and Principal Streets in the Business Part of the City.

	Day's work.	Rate per day, $.	Total cost, $.	Days per ft.	Cost per ft., cts.
Foreman ...	18.0	2.00	36.00	.0016	0.33
Men.	590.0	1.25	733.00	.0536	6.66
			769.00		6.99

B. Including 6,000 ft. of Trench in Bottom Land.

Foremen. ..	4.5	3.00	13.50	.0007	0.23
Men.	132.0	1.24	164.70	.0220	2.74
			178.2		2.97

C. Including 6,215 ft. of Trench Excavated with Men Only.

Foreman. ..	6.5	3.00	19.50	.0011	0.31
Men.	258.0	1.25	322.50	.0415	5.19
			342.00		5.50

D. Including 11,352 ft. of Trench Excavated Partly with Teams and Partly with Men.

Foreman. ..	8.0	3.00	24.00	.0007	0.21
Men.	247.0	1.23	304.00	.0218	2.68
Teams.	28.0	3.25	91.00	.0025	0.80
			419.00		3.69

E. Including 2,636 ft. of Dry Trench with a Uniform Depth of 3 ft.; also Included in D, Just Above.

Foreman. ...	1.0	3.00	3.00	.0004	0.12
Men.	45.0	1.25	56.25	.0171	2.12
Teams.	5.0	3.25	16.25	.0019	0.62
			75.50		2.86

F. Including 21,856 ft. of Ground Made Wet, and in Some Cases Muddy, by Frequent Rains.

Foremen. ..	15.5	3.00	46.50	.0007	0.2
Men.	702.0	1.24	874.40	.0321	4.0
Teams.	38.8	3.25	126.10	.0018	0.6
			1,047.00		4.8

TABLE II.—Details of 373 ft. of Trenching Passing Through Brick Pavement.

Labor Required.

	Days.	Rate, $.	Cost, $.	Cents per ft.
Removing bricks and piling upon sidewalk, and digging up concrete and putting it in piles to be used in relaying	Foreman..... .5	2.00	1.00	2.61
	Men 7.0	1.25	8.75	
Excavating trench 2 ft. wide and 3 ft. deep	Foreman..... .5	2.00	1.00	6.30
	Men..... 18.0	1.25	22.50	
Filling trench—tamping by men in best manner	Foreman..... 1.0	2.00	3.00	4.09
	Men..... 10.6	1.25	13.25	
Hauling away 23 loads surplus earth	Teams.....	.20	4.60	1.23
Labor relaying concrete	Men 7.8	1.25	9.75	2.61
Common laborers relaying bricks	.... 4.5	1.25	5.62	4.59
Professional pavers relaying bricks	.... 4.0	2.25	9.00	
" " helpers	.... 2.0	1.25	2.50	

Material required.

15 cu. yds. extra sand	1.00	15.00	4.02
1,700 extra bricks to replace those broken	14.00	25.80	6.92
18¼ bbls. extra cement to relay concrete	1.25	23.12	6.20
		143.89	38.58

Table III.—Time and Cost of Laying Pipe.

A. Including 4,038 ft. of 12-in. Pipe Laid in Part of the Trench Described Under Table I., A.

	Day's work.	Rate per day, $.	Total cost, $.	Days per ft.	Cost per ft., cts.
Foreman. ..	5.0	3.00	15.0	.0012	0.37
Bell-hole foreman.	6.0	2.00	12.0	.0015	0.30
Calkers.	34.0	1.64	56.0	.0084	1.39
Pipe and bell-hole men.	99.0	1.26	125.0	.0245	3.09
			208.0		5.15

B. Including 3,440 ft. of 10-in. Pipe Laid in a Part of the Trench Described Under Table I., A.

Foreman ...	4.5	3.0	13.5	.0013	0.39
Calkers. ...	25.5	1.70	43.2	.0074	1.26
Pipe men...	57.0	1.19	67.4	.0166	1.96
Bell-hole foreman.	3.0	2.00	6.0	.0009	0.18
Bell-hole men.	76.0	1.18	89.7	.0221	2.60
			219.8		6.39

C. Including 2,467 ft. of 10-in. Pipe Laid in Trench Described Under Table I., D.

Pipe foreman.	1.5	3.00	4.5	.0006	0.18
Calkers.	9.0	1.84	16.5	.0036	0.67
Pipe men...	19.0	1.19	22.6	.0077	0.91
Bell-hole foreman. .	1.5	2.00	3.0	.0006	0.12
Bell-hole men.	18.5	1.24	23.0	.0075	0.93
			69.6		2.82

D. Including 3,276 ft. of 8-in. Pipe Laid in a Part of the Trench Described Under Table I., A.

Pipe foreman.	6.5	3.00	19.5	.0020	0.60
Calkers.	26.8	1.57	42.2	.0081	1.29
Pipe and bell-hole men.	63.4	1.26	80.1	.0194	2.45
			141.8		4.34

E. Including 14,362 ft. of 8-in. Pipe Laid in Trench Described in Tables I., B. and D.

Pipe foreman.	9.8	3.00	29.4	.0007	0.21
Calkers.	52.5	1.75	92.2	.0036	0.64
Pipe men...	87.5	1.21	106.0	.0061	0.74
Bell-hole foreman. .	10.3	2.00	20.6	.0007	0.14
Bell-hole men.	111.5	1.26	140.8	.0078	0.98
			389.		2.71

F. Including 10,190 ft. of 8-in. Pipe Laid in Trench Described Under Table I., F.

Pipe foreman	8.0	3.00	24.0	.0008	0.24
Calkers.	43.9	1.82	80.0	.0043	0.78
Pipe men...	91.8	1.24	113.8	.0090	1.12
Bell-hole foreman. .	9.5	2.00	19.0	.0009	0.18
Bell-hole men.	94.8	1.25	118.5	.0093	1.16
			355.3		3.48

G. Including 9,937 ft. of 6-in. Pipe Laid in Trench Described Under Table I., D.

Pipe foreman.	5.7	3.00	17.1	.0006	0.17
Calkers. ...	29.5	1.84	54.3	.0030	0.54
Pipe men...	54.0	1.19	64.2	.0054	0.65
Bell-hole foremen. .	5.3	2.00	10.6	.0005	0.11
Bell-hole men.	61.3	1.25	76.6	.0062	0.77
			222.8		2.24

H. Including 9,855 ft. of 6-in. Pipe in Trench Described Under Table I., F.

Pipe foreman.	8.6	3.00	25.8	.0009	0.26
Calkers. ...	38.6	1.84	70.9	.0039	0.72
Pipe men...	75.2	1.22	91.5	.0070	0.93
Bell-hole foreman. .	7.7	2.00	15.4	.0008	0.16
Bell-hole men.	76.4	1.25	95.5	.0078	0.97
			299.1		3.04

does not compensate for the deep trench in cost, it will be near enough for practical purposes to consider al the trench 3 ft. deep. Where excavated by men alone it was 20 ins. wide at the top and 15 ins. at the bottom, and where excavated by teams and men, it was 3 ft. wide at the top and 15 ins. at the bottom.

In order to test the relative economy of excavating trench with and without the use of teams, a part of this trench was excavated with men alone (Table I., C) and another part with teams and men (Table I., D). The above comparisons were made when the weather was reasonably

Table IV.—Time and Cost of Filling Trenches.

	Day's work.	Rate per day, $.	Total cost, $.	Days per ft., per ft.	Cost cts.
A. Including 2,548 ft., Filled and Tamped by Men, of the Trench Described Under Table I., A.					
Foreman ...	3.0	2.00	6.00	.0012	0.24
Men	89.5	1.23	110.00	.0351	4.32
			116.00		4.56
B. Including 13,616 ft. of Trench, Filled and Tamped by Men.					
Foremen ...	14.0	2.00	28.00	.0010	0.21
Men	226.0	1.21	274.00	.0166	2.01
			302.00		2.22
C. Including 1,670 ft. of Trench, Filled by Men and Tamped by Horses.					
Foreman ...	1.0	2.00	2.00	.0006	0.12
Men	19.0	1.25	23.75	.0114	1.42
Boy	1.0	.50	.50	.0006	0.03
Horse	1.0	1.00	1.00	.0006	0.06
			27.25		1.63
D. Including 5,447 ft. of Trench, Filled by Scrapers and Men and Tamped by Horses.					
Foreman ...	4.0	2.00	8.00	.0007	0.15
Men	44.0	1.25	55.00	.0080	1.01
Boys	4.5	.50	2.20	.0008	0.04
Horses	2.0	1.00	2.00	.0003	0.03
Teams	6.1	3.25	19.80	.0011	0.36
			87.00		1.59
E. Including 9,620 ft. of Trench, Filled by Men and Tamped by Them at Street, Alley and Private Crossings, Only.					
Foreman ...	7.0	2.00	14.00	.0007	0.15
Men	77.0	1.25	96.25	.0089	1.00
			110.25		1.15
F. Including 11,433 ft. of Trench, Filled by Scrapers and Men and Tamped by Men at Street, Alley and Private Crossings, Only.					
Foreman ...	7.0	2.00	14.00	.0006	0.12
Men	83.0	1.25	104.75	.0073	0.92
Boys	6.0	.50	3.00	.0005	0.03
Teams	14.5	3.25	47.12	.0012	0.41
			168.9		1.48
G. Including 15,736 ft. of Trench, Being All the Filling not Listed Above.					
Foreman ...	13.0	2.00	26.00	.0008	0.17
Men	188.0	1.25	235.00	.0122	1.53
Boys	6.5	0.50	3.25	.0004	0.03
Horses	5.0	1.00	5.00	.0003	0.03
Teams	18.5	3.25	59.92	.0012	0.38
			329.20		2.14

good, and before the earth became thoroughly saturated, and the rainy days so frequent that only one or two days of continuous work could be done; one rain following another before the effects of the former had been overcome. The work done after this unsettled condition of the weather began is shown in Table I., F. In low wet ground, and in some high ground immediately after a heavy rain, the plow and scrapers could not be used to advantage. All work was done by men when earth of this kind was met. At times the plow could be used, but not the scrapers. The method of excavating the trench included in Table I., F, was changed as often as the conditions of earth or weather made it advisable to do so. Table I., C, includes 6,215 ft. excavated with men only. During the time this work was in progress there were two periods of rain.

Table I., D, includes 11,352 ft. of trench; the force was moved four times, and there was one rainy period while this work was in progress. The teams were used as follows: The center line of the trench was plainly marked with a pick. The trench was plowed by two pair of mules, one pair walking on each side of the trench. When the gravel crust was unusually hard, three teams were used until it was broken. Two or three teams with scrapers followed the plow and removed the loosened earth until a depth of 2 ft. was reached. Below this depth the plow loosened and men cast the earth from the trench, the scrapers not working well below 2 ft. By using a long chain on the plow, and having a man ride on the beam, the trench was plowed 4 ft. deep where necessary. So long as the earth was dry, small differences in its hardness made no appreciable change in the cost, as when plowed, it all shoveled or scraped easily. The scrapers used were 20 ins. wide.

While the average cost of all this work was 3.69 cts per ft., there were several divisions of it where the earth was all dry, and a trench of a uniform depth of 3 ft., and where there was no moving of the force, in which the cost came down to 3 cts. per ft. The best day's work was on a trench of this kind, the cost of which is shown in Table I., E., covering 2,636 ft. Table I., F, relates to 21,856 ft. of trench excavated in ground that was made wet, and in some cases muddy, by frequent rains. Two days of this work was done when the ground was frozen 3 ins. deep, and men picked holes through the frozen crust every 10 ft. to enable the plow to work. Three teams and three men were required on the plow until after the crust was broken.

The trench described in Table II. passed through 373 ft. of paving, consisting of one layer of bricks on edge, underlaid with 3½ ins. of sand and 7½ ins. of concrete. The paving was taken up for a width of 3 ft. The earth excavation was hard clay and gravel. A heavy rain stopped the excavation when half finished, making future work more costly. In relaying the concrete, 6 parts of the old concrete material was mixed with 1 part of Louisville cement. The small quantity of this work, and the unfavorable conditions under which it was done, make a high cost per foot. This work is included in Table I., A, as well as several other short pieces of expensive work, and details of time and cost are given in Table II.

Laying Pipe.

The pipe gang was in charge of William Moore, of Muncie, Ind., a man of much energy, ability and experience in such work. As all of his time was profitably employed in getting pipe into the trench and looking after the calking, a foreman was placed in charge of the bell-hole men. It was this man's duty to see that bell-holes were dug in the proper place, and fast enough to prevent any delay in putting in the pipe. The tables show how much more the state of the weather affects the cost of laying pipe than does the size of the pipe.

The time required for different sections of the pipe-laying, and the cost of the same, are shown in Table III., reference being made back to the conditions stated in commenting upon the character of the work included in Table I.

During the laying of the pipe included in Table III., B., there was no rain, but the ground was full of springs, and 1,500 ft. of the trench was very muddy. Men were kept constantly bailing water out of the trench. The condition of the trench made this 10-in. pipe cost more than the 12-in. of Table III., A.

In laying the pipe included in Table III., D., the men had not become familiar with the work, as this was the first pipe laid. The cost was increased by rain, sewers, pipes, etc. Poor weather was the cause of the pipe included in Table III., F, costing more than in Table III., E.

Filling Trench.

Several methods of filling were followed, according to the necessities of the case, and to test the economy of different plans. In the business parts of the city special care was taken to tamp the earth very thoroughly and put it back in the best possible manner. In the residence portions graded and graveled streets were well tamped when the earth was dry enough to admit of it. If too wet to tamp it would go back well enough without tamping. In tamping with men, two men stood in the trench and shoveled earth from the bank and placed it around the pipe. After this, came four men on the bank who filled in enough earth to make a 6-in. layer, which was tamped by four men in the trench with iron tampers. The trench was filled in this way to within 6 ins. of the top, when the remainder of the earth was filled over the trench without tamping. In some cases two horses ridden by boys were made to walk in the trench until it was tamped. In this way the trench was filled half full of earth and walked upon until it was hard, then filled to the top and walked upon again, then all the remaining earth put on loose. Trenches filled in this way were found to settle less than those tamped by men, and cost very much less. The horse cost $1 and the rider 50 cts. per day. It was found necessary to keep their foot-prints constantly covered with loose earth to prevent their stepping in the same place each time. It was arranged to fill by scrapers as much as possible, because they could handle wet as nearly as well as dry earth, while the wet earth required much more time of men than the dry. When scrapers were used two men handled the scraper, two or more men put earth around the pipe, and a few men cleaned up what earth the scraper failed to take. Each scraper could fill from 900 to 1,000 ft. of trench per day, under reasonably good conditions.

Table IV. gives details of filling in the trenches. The work included in Table IV., A, was all filled and tamped by men in the most thorough manner; over half of the earth was saturated by rain after excavation and before filling. The filling described in Table IV., E., is the same as that included under excavation, Table I., B, and the earth was very easy to handle. It should not be considered parallel with any of the other work.

Table IV., G., covers 15,376 ft. of filling, being all trenches not included in tables in the previous part of Table IV., embracing all kinds of work, wet, dry, frozen, tamped, untamped, with and without scrapers, filled in as was considered cheapest in each case. On two of the days included in this table, the earth was frozen so hard that it was necessary to loosen it with picks before the scrapers could be used. When there was not enough trench that required tamping to warrant keeping horses especially for it, the team was taken off the scraper to tamp for a short time.

Table VI.—Miscellaneous Items of Expense.

One team was employed the greater part of the time in moving the different gangs, hauling pipe and other material, re-surfacing trench, etc., in all 60 days, at $2.60	$156
Night watchman, 52 days, at $1.75	91
Checking pipe as received, and distributing, 56 days, at $1.16	65
Re-surfacing trench, repairing culverts, 16 days at $2.50; street crossings, etc., 126 days, at $1.23:	195
Replacing concrete, sand and paving on four streets crossed by pipe	44
Repairs to two 8-ft. masonry culverts crossed by pipe	44
Surveys and profile showing grades of streets	30
Picks and handles (men furnished their shovels)	29
Drilling and calking tools	31
Lanterns and all other tools	31
Traveling expenses of foreman	116
Three tool boxes, one lantern and one coalbox	18
Miscellaneous blacksmithing	25
Distributing pipe and specials, 1,370 tons, at 34 cts. (by contract)	466
All expenses not mentioned above, except superintendence	50
Total	$1,391
Cost per ft.	$.042

Lead and Hemp.

The record on lead and hemp was divided into 16 separate observations, including all the pipe laid; the results given in Table V. are the averages of these for each size of pipe. An inspection of the different observations showed that the faster pipe of any size was laid, the smaller the amount of lead used per joint. The depth of lead in the pipe of each size was made just enough to fill the recess cast in the bell. The table shows the same amount of lead per foot used in 8 and 10-in pipe. This is probably due to the difference in joint-room in the pipe. Instances have been known where 12-in. pipe required as little lead as 8-in., the results given on the latter sizes are the dry. There having been fewer observations, and less of the 10 and 12-in. pipe than of the 6 and 3-in., the results given on the latter sizes are the most reliable.

TABLE V.—Average Amount and Cost of Lead and Hemp.

Basis of averages. No. of observations.	Feet of pipe.	Size of pipe, ins.	Lead.* Pounds, per joint.	Pounds, per ft.	Cents, per ft.	Hemp.* Pounds, per joint.	Pounds, per ft.	Cents, per ft.
2	4,038	12	14.00	1.20	5.16	.42	.039	0.20
2	5,907	10	10.53	.955	3.82	.43	.039	0.20
5	27,829	8	10.61	.955	3.82	.34	.031	0.16
7	19,780	6	7.52	.66	2.64	.223	.019	0.10

Miscellaneous Items.

A list of miscellaneous items of expense is given in Table VI.

Recapitulation.

Since the cost of laying pipe is governed more by the condition of the weather and trench than by the size of the pipe, the results of the foregoing tables are combined in Table VII., to show the cost of laying each size of pipe under the worst, average and best condition of excavating and filling.

Table VII.—Cost per Foot of the Several Sizes of Pipe in Place, According to Worst, Average and Best Weather.

	Conditions.	Cost per foot, cts. 12-in.	10-in.	8-in.	6-in.
Excavating trench.	Worst....	6.99	6.99	6.99	6.99
	Average..	4.88	4.88	4.88	4.88
	Best.....	2.97	2.97	2.97	2.97
Laying pipe	Worst....	5.15	6.40	4.34	3.03
	Average..	5.15	4.91	3.09	2.64
	Best.....	5.15	2.82	2.71	2.24
Filling trench.	Worst....	4.56	4.56	4.56	4.56
	Average..	1.79	1.79	1.79	1.79
	Best.....	1.14	1.14	1.14	1.14
Lead and hemp.	Average..	5.36	4.02	3.98	2.74
Miscellaneous.	Average..	2.42	2.42	2.42	2.42
Total cost.	Worst....	24.48	25.73	23.63	22.36
	Average..	19.00	18.02	16.16	14.47
	Best.....	17.04	13.37	13.22	11.51

Table VIII.—Daily Progress of Pipe-Laying.

Date.	Size, ins.	Feet laid.	Remarks.
Oct. 25 to Nov. 1....	8	3,276	Rain on two days.
Nov. 2 to 11.....	12	4,038	Rain on three days.
Nov. 12 to 16.....	10	3,440	Rain on the 16th.
" 17.....	8	900	Muddy; gang moved.
" 18.....	8	1,630	Dry; some deep trench.
" 19.....	8	1,300	Marshy ground; very muddy.
" 20.....	...	...	Sunday.
" 21.....	8	823	Crossed Ry. yard of six tracks.
" 22.....	8	1,856	Good trench.
" 23.....	8	1,736	" "
" 24.....	8	675	Crossed Ry. yard of three tracks; gang moved.
" 25.....	8	1,217	Muddy.
" 26.....	...	...	Rain.
" 27.....	...	...	Sunday; rain.
" 28.....	6 & 8	1,170	Very wet and muddy.
" 29.....	6	1,217	" " "
" 30.....	6	1,483	Part muddy, part dry; gang moved.
Dec. 1.....	6	2,220	Good trench; gang moved.
" 2.....	6	1,890	1,400 ft. of this was good trench.
" 3.....	6	1,610	Good trench; gang moved.
" 4.....	...	...	Sunday.
" 5.....	6	845	Unavoidable delay; gang moved.
" 6.....	6 & 8	1,375	Rain stopped work at 3 p. m.
" 7.....	8	1,380	Muddy; some deep trench; crossed one Ry. track.
" 8.....	8	1,620	Dry trench; one deep culvert and one Ry. track.
" 9.....	8	2,130	Dry trench; uniform depth of 3 ft.
" 10.....	8	1,810	Dry trench in a. m.; muddy in p. m.
" 11.....	...	...	Sunday.
" 12.....	...	...	Rain.
" 13.....	8	460	Rain in a. m.; worked p. m.; much water and mud.
" 14.....	8	1,675	Muddy.
" 15.....	8	1,290	Rain p. m.; crossed deep culvert.
" 16.....	...	...	Rain.
" 17.....	8	1,580	Much mud and water.
" 18.....	...	...	Sunday.
" 19.....	...	...	Rain and snow.
" 20.....	8	485	Cold; ground frozen; snow and ice; gang moved.
" 21.....	10	1,600	Muddy.
" 22.....	8 & 10	1,467	"
" 23.....	6 & 8	1,520	"
" 24.....	6	1,665	"
" 25.....	...	...	Sunday.
" 26.....	6	335	Very cold; few men in p. m. only; gang moved.
" 27.....	6	1,400	Very cold.
" 28.....	6	1,223	Cold; gang moved.
" 29.....	6	1,824	Some deep trench; gang moved.
" 30.....	6	550	Showery and muddy; worked 8 hrs.
" 31.....	6	564	Showery and muddy; worked 5 hrs.
Jan. 1.....	...	...	Sunday.
" 2.....	6	286	Much mud and water; finished at 11 a. m.

Summary, Total Work:

No. of days from beginning to end of work.....	70
Ave. number of feet per day, beginning to end of work	802
No. of days on which pipe was laid.....	50
Ave. ft. per day of days worked.....	1,151

Summary, After Leaving Business Section of Town:

Total number of days.....	40
Ave. ft. per day.....	935
No. of days on which pipe was laid.....	38
Ave. ft. per day of days when pipe was laid.....	1,232

The work could have been done cheaper if it had not been done quite so fast, but the lateness of the season made it more economical to expend a little money in speed and complete the work before the winter weather set in.

The daily progress of pipelaying, with remarks on the character of the work and on the weather, is shown by Table VIII.

Table IX.—Time and Cost of Laying 6,000 ft. of Table VIII.—Daily Progress of Pipelaying.

		Day's work.	Rate per day. $.	Total cost. $.	Cents per ft. ft.	
Excavating trench.	Foreman..	1.9	3.0	5.70	.0003	0.09
	Men.....	82.0	1.25	102.50	.0136	1.71
	Teams.....	2.6	3.25	8.45	.0004	0.14
				116.65		1.94
Laying pipe.	Foreman...	2.0	3.0	4.0	.0003	0.06
	Men.....	8.5	1.25	10.62	.0014	0.18
				14.62		0.24
Filling trench.	Foreman...	1.75	2.00	3.50	.0003	0.06
	Men.....	27.50	1.25	34.37	.0046	0.57
	Teams.....	1.40	3.25	4.55	.0002	0.07
				42.42		0.71
Distributing pipe, haul 3½ miles.	Team.....	2.5	3.25	8.12	.0004	0.13
Total cost.....				181.80		3.02

In addition to the cast iron pipe, 6,000 ft. of 2-in. wrought pipe was laid in a trench 2 ft. deep in the residence portion of the city. The earth was wet, but not enough so as to be muddy. Teams plowed trench and filled with scrapers whenever they could work to advantage; 1,000 ft. of the trench was tamped by the scraper team, but the rest was not tamped. The details of time and cost involved in this work are shown by Table IX.

HEAVIER RAILS.

The question of the use of heavier rails, and the advantages to be derived from their use in point of efficiency and economy, is one of direct and particular interest in this country where increasing traffic is inducing a steady increase in the use of heavier rails, and where much heavy traffic is still carried over rails much too light for either efficiency, economy or safety. In this connection we give below an interesting letter from Mr. C. P. Sandberg, the well known rail expert, and have added some comments thereto. The breakage of rails in Denmark during the winter of 1891-2 was referred to in our issue of July 7, 1892.

As the present winter is one of the most severe of this century for many countries it has naturally affected the safety of all railway plants, particularly the rails. In Russia and Scandinavia mercury has often frozen, so that spirit thermometers have had to tell the degree of cold. America has also experienced an unusually severe winter. It is then only natural that some railway accidents arising from broken rails and rolling stock should have taken place, but on the whole they are comparatively not so many as in olden times—when iron was used for rails—so that steel seems to suffer less through cold than iron. Indeed it appears that most of the fractures have been caused by insufficient weight of rail. The constant low temperature, such as in winter, is not the worst, the change of temperature in the day and night in the spring, along with the thaw of the roadbed producing unevenness, is even a greater test for a rail. There is then, for such an occasional extra strain as produced by such a winter as this, a surplus of strength required to avoid breakages and accidents. This niggardliness in giving insufficient weight in the olden time was caused by the high price of, say, £20 per ton at the introduction of steel rails, 20 years ago. Now the price is under £4 ($19.48), or less than it ever was for iron rails, so there does not exist any reason for saving the material; on the contrary, it is economical to use heavier rails, as more than half the value is recouped by selling the old worn rails, and it also lessens the cost of maintenance of permanent way considerably, besides securing safety from accidents. It was these altered conditions of things that brought me to design my so-called "Goliath" rail, 100 lbs. per yd.

The flange rail has since been adopted in Belgium with slight modifications, and rails have generally been made heavier in most countries. But there is at present a special reason for progressing faster in this direction, for never was the want of heavier rails more felt than through this severe winter, and never were rails so cheap as just now. It was not with a view of introducing this 100-lb. flange rail in England, where the roads with chairs are the strongest and safest in the world, but with the object of ascertaining whether with flange rails as good and safe a permanent way could be obtained by giving more weight to it that the Furness Railway was induced to lay down two years ago, on the main line near Barrow, one mile of 100-lb. flange rail such as I designed in 1886, alongside of their usual type of road. So far it has proved good. The rails were made at the Barrow Steel Works, and they stood a traffic of 2,000,000 tons without any measurable wear, as shown by impressions from rails taken up and compared with original section, of which one is reproduced herewith. The cost of road is about the same for the two types, and the run of high speed is even smoother on the flange rail than on the English rail, with no knocking of loose rail joints. Some prophets have predicted a rapid wear from interior porousness of the steel in the big rail head, but it does not show that by experience; besides, the head is no bigger than that of the ordinary English bullhead rail. If this experience continues equally favorable the object of design and trial will be reached, viz., to show whether as good a permanent way can be had with flange rails as with the bullhead and chair, if equal weight is given it. This will be a great benefit to all railways using flange rails, and they exist everywhere except in England; for with a heavily worked road it is almost an impossibility to change type of rail, but heavier sections can be easily introduced. If America is going to increase its speed to 100 miles per hour, as is now talked about, the railways will require to relay their tracks with heavier rails first. Anyhow it shows their faith in the flange rail—and never was there a more favorable time for renewal than just now.

The accompanying section is reduced one-half from a direct impression from a rail end. The wear shown is hardly perceptible, and yet one interesting transformation has occurred; the gage side (the left) has worn to a distinctly sharper corner radius than the other and unworn side, the contrast being nearly as ¼ to ½ in. It may be added that, although now may be the most favorable time to buy rails abroad, it is a particularly poor time to buy them here, in excess of immediate necessities, in view of the impending changes in the tariff, which are quite certain to bring down the price of rails, like a shot, from the present rates of $20 to $30, to some $24—even if not lowered to the point of permitting foreign importations any more than they do to-day. Among all the real and alleged abuses of the tariff there certainly has not been one more excusable than maintaining the steel rail tariff at the present high rate with the sole effect of enabling the only five producers of rails, between whom the closest kind of a combination exists, to maintain for the past six or eight years a level price of $30 per ton (now lowered to $29), in the face of a steady decline in the price of raw materials and steady improvement in processes of manufacture, which warranted a fall to $24 at least.

100-lb. Rail of Sandberg Section After Two Years' Service (2,000,000 Tons Traffic) on the Furness Railway, England.

The Sandberg Goliath rail has been illustrated and described in our issues of May 21, 1887, Nov. 9, 1889, and July 18, 1891, and it has been laid in the St. Clair tunnel of the Chicago & Grand Trunk Ry. (Eng. News, Dec. 6, 1890). It is hardly necessary to repeat again the fact that more additional weight does not insure better quality, as a heavy rail insufficiently rolled may give much less satisfactory service than a lighter rail thoroughly rolled. This was very clearly seen in the early days of English railways, where 70 and 80 lb. rails were found so inferior that in many cases

they were replaced with the older 50 and 60 lb. rails, which were cheaper and had a longer life. This was due to the lack of facilities for the proper rolling of such large rails, but with modern rolling mill plant 100-lb. rails can be properly rolled without difficulty. Still it is well to bear in mind that the mere addition of weight in metal does not in itself necessarily imply that the heavier rail will be better or more economical than a lighter rail. The question of track labor in regard to the use of light or heavy rails was discussed at the convention of the New England Roadmasters' Association in August, 1892 (Eng. News, Sept. 1, 1892) with the result that the heavier rail was approved, as making a better and more easily maintained track, and not appreciably increasing the general section work.

A CASE OF ARCHITECTS' FEES IN ENGLAND.

A case was lately tried in England before Lord Chief Justice Coleridge which bears upon the fixing of architects' fees by the Royal Institute of British Architects, and the view of the court in regard to the payment of fees thus fixed. An architect claimed $2,250 as fees and charges in connection with preparing the plans for two houses, basing his charges upon the fee-schedule of the Royal Institute, or 3% on the lowest tender for the work. The defense was that the defendant ordered plans for two houses to cost $20,000; and on the plans prepared the lowest tender was $35,335. He offered the architect $550 in full for his services, which fee he paid into court, and from another architect obtained plans on which he built his houses for $17,500.

The lawyer for the plaintiff said that his fees were strictly in accordance with the terms fixed by the Royal Institute. He charged 3% on the lowest tender of $35,335; 2% on this tender for preparing a bill of quantities; and there was a charge of about $250 for lithographing quantities, $105 for preparing specifications of alterations, $50 for surveying site and some smaller items, which brought the total to $2,250. The plaintiff's plans called for a cubic contents of 116,870 cu. ft.; at 12 cts. per foot, the expense would have been about $20,000, but this would call for a building of the plainest possible type. He claimed that the defendant wanted a building that would cost from 18 to 20 cts. per cubic foot, and he was told that this figure meant a cost of from $30,000 to $35,000. The plans were approved and tenders asked for, with the result given.

Lord Coleridge said he would not allow the Royal Institute to dictate to juries what price should be paid for work not done. He put the case shortly by saying that, from evidence, the defendant ordered plans for a cost of $20,000 and the plaintiff sent in plans for a cost of nearly $40,000, fees included.

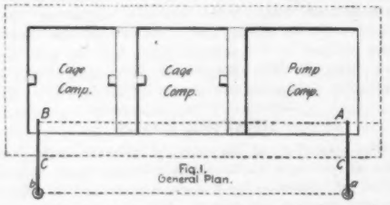
Lord Coleridge further said that the defense rested on this—that the expense of the building was not to exceed $20,000, which was all the defendant was bound to expend. It was not likely that he would expend $40,000; his case was that the plaintiff, his architect, knew this. If the employment was to prepare plans for a building which could be erected for $20,000, plans which would involve an expense of nearly $40,000, were certainly entirely different from what was desired. The case for the plaintiff was that the defendant saw the plans and approved of them, and had alterations made in them. Undoubtedly architects did not strictly keep within their employer's limit of expenditure, and on the other hand, the employer was easily induced to countenance an increase of expense here and there upon such pleas as architects knew how to urge. In the present case, although the tenders came near $40,000, the defendant's letters did not look like a total repudiation. Could the defendant then entirely repudiate the employment of the plaintiff? If not, then it became a question what was reasonable, and that was for the jury to consider. It was said that the Institute of Architects had settled certain charges on the estimated amount of expenditure. But a commission upon expenditure incurred was open to the gravest possible objection. His lordship referred to a case of a gentleman who wished to build a house and was willing to pay $250,000 upon it. His architect prepared plans for one to cost $750,000, and said: "Well, you may or may not build it, but in any case you must pay me commission upon $750,000., for the Institute of Architects says so." He confessed his legal soul fired at it; he hoped that no British jury would ever yield to what was a most unjustifiable attempt by a body of men to increase their own emolument. He told them distinctly unless they were satisfied the defendant had agreed to pay the percentage he was not liable to pay it.

The jury found for the plaintiff for $1,000, including the sum paid into court.

METHOD OF PLUMBING SHAFTS.*

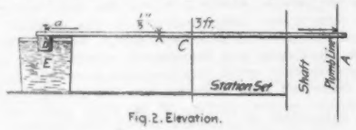
The following method of plumbing a shaft suggested itself to me as practicable, and at the same time more accurate than the methods commonly employed. It consists in obtaining a longer base by suspending the plumb lines from the extreme corners, lengthwise of the shaft, and reproducing the bearing by offset-points on sticks attached to the plumb-lines, and supported on floating corks. This allows the wires freedom of motion, while at the same time steadying them. The points are then taken up by trial-setting, or by setting over one point and taking a direct sight to the other.

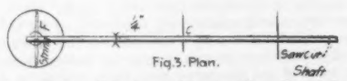
Fig. 1 represents a three-compartment shaft, the partitions of which would prevent, in the usual methods, the employment of a base longer than could be got in one compartment, or, say, 4 ft. But at the station on each level there will be a clear space along the whole shaft, or at least the two cage-compartments. In the case illustrated, it is assumed that the whole inside



length of the shaft will be available for observations at the station; and the wires A and B are hung on the line of known bearing, A B, in the corners of the shaft. The bobs of A and B at the bottom of the shaft hang in vessels filled with water and covered.

At the first level, sticks C C are attached to wires A and B, by causing the latter to pass through saw-cut grooves, into which candle-drippings are allowed to fall, in order to make them hold the wires more firmly. These sticks extend into the station, as shown at a and b, Fig. 1, and on a larger scale by the elevation





and plan of the stick A a, given in Figs. 2 and 3; and the other end of each is supported at a pin-point, a, at a measured distance from the plumb-wire, upon a cork, D, floating in a vessel filled with water. A 5-lb. lard can answers very well for this vessel. The stick must be level when it is thus floated on D. The distance from pin-point, a, to the similar point, b, on the stick from B (Fig. 1) must be kept practically the same as the distance A B between the plumb-wires. This is done with sufficient accuracy, after properly placing the vessels, by means of the arrangement shown in Fig. 3, in which F is a piece of thread, looped loosely around pin-point, a, and passed through a hole in one side of the can (see D, Fig. 2), then over the stick and through a hole on the other side, and then tied to itself. This keeps the cork practically in the center of the can, and at the same time allows motion in the direction a A.

If room permits, the instrument can be set in the line of pin-points, a—b. Or, it can be set over pin a, and sight taken to b, which gives the same bearing as the line between the wires.

This method has given me very satisfactory results, as might be expected, since it permits the use of a base of 13½ ft. (three compartments), or 8 ft. (two compartments), as against 4 ft. for vertical sighting, with or without string-base.

* Abstract of a paper by A. Neustaedter, presented at the meeting of the American Institute of Mining Engineers, at Montreal, February, 1893, as reported in our issue of March 2.

PERSONALS.

Mr. G. W. Woodward, City Engineer of Hastings, Neb., has resigned.

Mr. C. H. Ackert, General Manager of the Iowa Central Ry., has resigned.

Mr. Rudolph Hering, sanitary engineer, has been engaged to design a system of sewerage for Charlottesville, Va.

Gen. Wade Hampton, of South Carolina, has been nominated by President Cleveland to be U. S. Railway Commissioner.

Mr. S. H. H. Clark, President and General Manager of the Union Pacific Ry., has been elected President of the Missouri Pacific Ry. Co.

Mr. Grant M. Hall has been appointed Mechanical Engineer of the Intercolonial Ry., with headquarters at Moncton, N. B., vice Mr. E. May.

Mr. W. H. Fritchman has resigned his position as Superintendent of the water-works at Peoria, Ill., and has been succeeded by Mr. D. H. Mawry, Jr.

Mr. Cornelius Shields, General Superintendent of the Western Division of the Great Northern Ry., has been appointed to succeed Mr. C. W. Case, as General Superintendent of the Eastern Division.

Mr. O. H. Tripp, City Engineer of Rockland, Me., from 1887 to a recent date, will continue his private practice in that city, which he began in 1885, and has maintained in connection with his official position.

Mr. Otto Miller, Division Superintendent of the Chicago & Northwestern Ry., at Chicago, has been appointed Superintendent of the Hutchinson & Southern R. R., with headquarters at Hutchinson, Kan., vice Mr. F. P. Byers, resigned.

Mr. J. Berlingett, of Des Moines, Ia., formerly Superintendent of the St. Joseph Division of the Chicago Great Western Ry., has been appointed General Superintendent, with headquarters at Oelwein, Ia. The shops of this road will be removed to Oelwein.

Mr. Frank M. Nichols, bridge contractor of Fort Atkinson, Wis., died at Anniston, Ala., recently. Many of the bridges on the Madison & Milwaukee Division of the Chicago & Northwestern Ry. were built by him. He was born in Utica, N. Y., Dec. 23, 1850.

Col. Henry Clay Comegys, a well known contractor, died of pneumonia in New York, March 22, at the age of 53. For many years he was engaged in the promotion and building of gas, electric and water works, and at the time of his death was interested in several such concerns.

Mr. Charles L. Woodbury, Constructing Engineer at the Plattsburg, N. Y., military post, has been ordered to report to Capt. Guy Howard, Assistant-Quartermaster, U. S. A., at Burlington, Vt., to have charge of the engineering work on the new Fort Ethan Allen, at Essex Junction.

Mr. George E. Datesman has been appointed Principal Assistant Engineer and Surveyor in the Bureau of Surveys, Pittsburg, Pa., vice Mr. George S. Webster, promoted; and Mr. F. T. Block has been appointed District Surveyor for the Fourth Survey District, vice the late Mr. W. W. Thayer.

Mr. W. S. Morris, Master Mechanic of the Chicago & West Michigan Ry., with headquarters at Grand Rapids, Mich., has resigned to take the position of Superintendent of Motive Power of the Chesapeake & Ohio Ry., succeeding Mr. Wm. Garstang, who succeeds Mr. E. A. Lord, on the Cleveland, Cincinnati, Chicago & St. Louis Ry.

Mr. W. H. Fry, formerly with the Pullman Palace Car Co., has been appointed Superintendent of the Car Department of the New York, New Haven & Hartford R. R. He will oversee all the work done in the company's shops, which are located in New York, New Haven, Providence and Valley Falls, making his headquarters in New Haven, Conn.

Mr. J. W. Howard, well known as an expert on asphalt and street paving, will be in charge of the exhibit of the Barber Asphalt Paving Co., in the Department of Mines and Mining, at the World's Columbian Exposition. He is also to make tests and records of traction on different roads and pavements for the Department of Agriculture.

Mr. Robert Peary, C. E., U. S. N., has joined forces with Prof. Angelo Heilprin, of the Academy of Natural Sciences, in Philadelphia, in his forthcoming Greenland Expedition. The Philadelphia Geographical Club, of which Professor Heilprin is President, has issued a letter asking for contributions to this end. The club estimates the cost at about $25,000, not including the return. The greater part of this will be contributed by Mr. Peary himself. As outlined, the plan now is that Mr. Peary will lead his expedition north, and Professor Heilprin will go south along the Greenland coast, from the common landing point.

Mr. A. A. Robinson has resigned his position as Second Vice-President and General Manager of the Atchison, Topeka & Santa Fe R. R., to go to the Union Pacific Ry. He became Chief Engineer in 1873, and has been at the head of the Construction Department for nearly 20 years, resigning the title in 1892. He was also General Superintendent from 1883 to March, 1884, then General Manager and Chief Engineer, and in 1886 was appointed Vice-President also. Mr. J. J. Frey has been appointed General Manager, with office at Topeka, Kan., to succeed Mr. Robinson; but the office of Vice-President has not been filled. Mr. Frey was formerly General Superintendent of the Missouri, Kansas & Texas Ry.

Mr. John Taylor Johnson, the originator, and for many years the President, of the Central R. R. of New Jersey system, died at his home in New York on March 24. Mr. Johnson was born in New York on April 8, 1820. He was a student in the Edinburgh High School, and graduated from the University of the City of New York in 1839; he also took a course at Yale and studied law. In 1848 he was made President of the Somerville & Eastern R. R., and from this small beginning evolved the system now known as the Central R. R. of New Jersey. He lost a great part of his fortune in the collapse of coal stocks in 1876. He was well known as a patron of the fine arts, and was a founder of the Metropolitan Museum of Art; was its first president, and was honorary president for life.

NEW PUBLICATIONS.

MANUAL OF IRRIGATION ENGINEERING. By H. M. Wilson, C. E. New York: John Wiley & Sons; 8vo, pp. xx., 351; 29 plates, 100 figures in the text and 13 tables. Price, $4.

Until about a year ago there was no general work on irrigation designed for American engineers. At that time a double volume was published by Mr. P. J. Flynn, entitled "Irrigation Canals and other Works" and "Flow of Water in Irrigation Canals, Etc." This double volume was somewhat bulky and rather costly, the price being $8.00, and suggested the advisability of two separate volumes, the second part really being a very complete work on the hydraulics of the subject.

Mr. Wilson, in the volume under review, has covered about the same ground as did Mr. Flynn in the first part of his work, but on a somewhat different plan, and, it is only fair to state, in a thoroughly independent way. If, therefore, justification were needed for publishing a book on a subject so recently treated by another it would lie in greater convenience and less cost of the more recent work; the addition of new matter and a different treatment of the subject; the intimate acquaintance of the author with much of the so-called arid region; and the fund of information secured in a trip made in 1889-90 to visit the principal irrigation works of India, and some of those in Italy and France. This trip, it may be added, is outlined, and the works seen in India are described in detail in the twelfth annual report of the United States Geological Survey, also noticed in this issue

The subject is treated under the three heads, Hydrography, Canals and Canal Works, and Storage Reservoirs. It is, of course, impracticable to give more than a general idea of the contents of such a book. It seems sufficient to say, in addition to what has preceded, that the various sub-divisions of the three main divisions just named are treated clearly, practically and at fair length, while for more detail numerous references are made to other writers. The illustrations and descriptions of existing irrigation works are well selected and will be helpful. Among the illustrations are sections of quite a number of the large dams of the world. The execution of the half tones is often poor. A good index is provided.

IRRIGATION IN INDIA.—By Herbert M. Wilson, C. E. Extract from the Twelfth Annual Report of the Director of the U. S. Geological Survey, 1890-1. Pub. Doc., 4to, pp. 222; 40 plates and 31 figures in the text.

This volume describes in detail some of the more prominent irrigation works of India, principally such as "exist under conditions similar to those in the United States." The text is founded principally on: "(1). Conversation with the engineers in charge of works, and examination of their office material; (2), personal examination of the works themselves, and (3), books and official reports." Mr. Wilson reached Bombay Jan. 31, 1890, and remained in India about two months. The execution of some of the half-tones is highly commendable, as is the general typography of the book. A folding map of India is included, and also a list of authors consulted on Indian irrigation. The volume, as a whole, will rank high with the other government publications on irrigation.

In Engineering News of Nov. 21, 1891, there appeared an article by Mr. Wilson on "Irrigation in India: Its Value and Necessity," which gave some of the general information included in this report. Some of the descriptive matter and illustrations given in the report may also be found in the "Transactions of the American Society of Civil Engineers," vol. xxiii., pp. 217-60. Two extensive articles on the irrigation works of India will be found in our issues of Nov. 10 and Dec. 22, 1892.

CURRENT ART AND ARCHITECTURE. Devoted to Painting and Sculpture, Interior Decoration, Decorative Architecture and Industrial Art. Monthly. The Current Art Co., 70 Fifth Ave., New York. $3.00 per year, or $5.00 with an etching each month.

This is a new art publication, commencing with March, 1893, and if the promise of this first number is kept up, in the quality and character of its illustrations, it has come to stay. The special feature of this issue is a series of reproductions of the work of Evert Van Muyden, a painter-etcher, almost unknown to fame in the United States; but as powerful and certain in his treatment of wild animals as were Eugene Delacroix or Barye. The numerous examples of decorative ironwork are unusually well selected from the works of prominent architects, and the same may be said of the photo-reproductions of interiors. The paper and press-work leave nothing to be desired.

TRADE PUBLICATIONS.

HINTS ON STEEL.—Carpenter Steel Co., Reading, Pa.; 16mo.; pp. 48.

This is an interesting little pamphlet, containing hints on the manufacture of steel, and the processes of forging, tempering, hardening, annealing, etc. There are also notes on the company's specialties of air-hardened and other grades of special crucible steel, cold rolled steel, and forgings, together with tables of sizes and weights of steel. The Carpenter process and works were described in our issue of Oct. 20, 1892.

THE PELTON WATER WHEEL.—The Pelton Water Wheel Co., San Francisco and New York. 8vo, pp. 100; illustrated.

The Pelton wheel and its applications to various arrangements of power plant have been several times described and illustrated in our columns. In this catalogue, plants for hoisting, pumping, mining, compressed-air plant, driving belt wheels for power shafting, etc., are illustrated and described. There is a price list, and also a table of comparisons of various water motors, made at the University of Michigan. There are several tables of power, etc., of wheels of various sizes, together with general hydraulic tables for tank and weir measurement, loss of lead in pipe by friction, price and weight of riveted pipe, power transmission, etc. Among other specialties mentioned is the Rife automatic hydraulic engine for elevating water for irrigation, and for railway and other tanks, etc.

GATES, VALVES AND FIRE HYDRANTS: Manufactured by the Chapman Valve Manufacturing Co., with an Engineering Appendix. Indian Orchard, Mass. 12 mo., pp. 300. Illustrations and tables.

This volume contains detailed descriptions of the gate valves and fire hydrants made by the above firm, and in addition some 200 pages on steam, electricity and refrigeration, much of which was written for this book. Many useful tables are included in the volume, making it a handy reference book.

SOCIETY PROCEEDINGS.

NORTHWEST RAILROAD CLUB.—At the meeting on March 14 a paper on "The Use of Compressed-Air in Railroad Shops," was read by Mr. Wm. McIntosh.

NORTHWESTERN WATER-WORKS ASSOCIATION.—The semi-annual meeting was held at the Ranier Hotel, Seattle, Wash., March 22. The following papers were read: "The Development of a Water System in Western Cities of Phenomenal Growth," W. E. Wilson; "Wood Stave Pipe," A. McL. Hawks; "Forms and Records Used in the Operation of Water-Works," Charles B. Hurley; "Water Rates," W. F. Newell. The association visited the pumping stations by invitation of Mr. W. E. Wilson, Superintendent of the Seattle Water-Works. W. G. Gaston, Secy.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting on March 18, Vice-President James Christie in the chair, 55 members and visitors present.

Mr. Geo. S. Webster exhibited, by means of the projecting lantern, a series of photographs of all the important bridges in Philadelphia that had been built by the City Survey Department, and described their principal dimensions and interesting engineering features. In many cases the bridges were represented by two or more photographs from different points of view, and reproductions of the working drawings. The secretary announced the death, on March 14, of Mr. W. W. Thayer. L. F. Rondinella, Secy.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—The annual meeting was held March 14, President Rice in the chair. The annual report of the secretary, treasurer and librarian were read. Mr. W. R. Warner read a report on "The Progress of Mechanical Engineering During the Past Year," and Prof. E. P. Roberts read a similar report on, "The Progress of Elecerical Engineering." The following officers were elected for the coming year: President, A. H. Porter; Vice-President, C. S. Howe; Secretary, F. C. Osborne; Treasurer, C. P. Leland; Librarian, C. H. Benjamin; 1st Director, C. W. Wason; 2d Director, James Ritchie. The paper of the evening was the annual address of the president, on "The Mission of a Local Civil Engineers' Society." Chas. S. Howe, Secy.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—The next meeting will take place at the Kimball House, Atlanta, Ga., April 20. The subjects for discussion will be as follows:

"Air-Brake Practice; Piston Travel in Inches, and Determination of the Actual and Available Brake-Power," W. J. Hartman, J. M. Holt and R. E. Libby; "What Are the Best Devices and Appliances in Draft Rigging and Draw-Bars to Prevent Damages and Wrecks, and Reduce Maintenance of Those Parts," R. D. Wade, C. B. Gifford and F. H. McGee; "Soft Plugs for Crown-Sheets of Fire-Boxes; Best Form and How to Keep Them Effective," Philip Wallis, T. W. Gentry, W. Hassman and W. T. Hooker. The committee on "Stay-Bolts Inspection," R. P. C. Sanderson, Chairman, is expected to make a report.

S. A. Charpiot, Secy.

CENTRAL RAILWAY CLUB.—At the meeting on March 22 an amendment to the constitution was proposed, changing the dates for the meetings held in November and May, to October and April. The committee on a form of defect card to cover partial repairs to cars reported a form, and an amendment to Rule 5 of the Interchange Rules, requiring the partial repair card to be used to cover partial repairs necessary for the safe running of the car, of the defects noted on the original M. C. B. card. The repairs so made should be struck off the original card, which should be left on the car. The application of wrong drawbars in making repairs was discussed at some length, and then a committee report was submitted on smoke prevention and efficient combustion in locomotives. This report recommended the use of brick arches in the firebox, larger exhaust nozzles, compounding of the steam, cylinders, and the education of firemen to proper methods of working. In the discussion which followed, the use of the brick arch was approved by Messrs. Waitt, Campbell, Griffith, West, Higgins, Dolbeer and Garrison, and was opposed by Mr. Mackenzie. At the next meeting, to be held April 20, amendment to the Rules of Interchange will be discussed.

COMING TECHNICAL MEETINGS.

SWEDISH ENGINEERS' CLUB.
April 1, Secy., P. Valentine, At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.

ENGINEERS' CLUB OF PHILADELPHIA.
April 1. 1122 Girard St., Secy., L. F. Rondinella.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
April 3, Secy., C. L. Annan, City Engineer's Office.

ENGINEERS' SOCIETY OF PHŒNIXVILLE.
April 4, Secy., W. Halliburton.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
April 5, Secy., F. Collingwood, 127 East 23d St., New York.

ENGINEERS' CLUB OF ST. LOUIS.
April 5, Secy., Arthur Thacher, Odd Fellows' Building.

WESTERN SOCIETY OF ENGINEERS.
April 5, Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.

ENGINEERS' CLUB OF MINNEAPOLIS.
April 6, Secy., E. Nexsen, 504 Kasota Block.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
April 7, Secy., F. E. Smoot, 808 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
April 7, Secy., O. Von Geldern, 719 Market St., San Francisco.

MONTANA SOCIETY OF CIVIL ENGINEERS.
April 8, Secy., F. D. Jones, Helena.

WISCONSIN POLYTECHNIC SOCIETY.
April 10, Secy., M. F. Schinke, City Hall.

ENGINEERS' CLUB OF KANSAS CITY.
April 10, Secy., Waterman Stone, Baird Building.

ATLANTA SOCIETY OF CIVIL ENGINEERS.
April 11, S. W. Spear, E. Buffalo, N. Y., Iron Works.

NORTHWESTERN SOCIETY OF ENGINEERS.
April 11, Secy., D. W. McMorris, Burke Block, Seattle, Wash.

NORTHWEST RAILROAD CLUB.
April 11, Ryan Hotel, St. Paul, Secy., W. D. Crosman.

DENVER SOCIETY OF CIVIL ENGINEERS.
April 11, Secy., F. E. King, Jacobson Block.

CIVIL ENGINEERS' CLUB OF CLEVELAND.
April 11, Secy., C. Foss.

CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
April 12, Wichita, Kan.

NEW ENGLAND RAILROAD CLUB.
April 12, Secy., F. M. Curtis, O. C. R. R., Boston.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
April 13, Secy., F. W. Mowbray, Norton Building.

ENGINEERING ASSOCIATION OF THE SOUTH.
April 13, Secy., O. H. Landreth, Nashville, Tenn.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
April 14, Secy., D. W. Meeker, St. Paul.

COLUMBIAN ENGINEERING SOCIETY.
April 18, Secy., F. W. Hart, Washington, D. C.

WESTERN RAILWAY CLUB.
April 18, Secy., C. F. Street, Rookery Building, Chicago.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
April 18, Secy., E. H. Clark, Pittsburg.

BOSTON SOCIETY OF CIVIL ENGINEERS.
April 19, Secy., S. E. Tinkham, 36 Broomfield St.

ASSOCIATION OF ENGINEERS OF VIRGINIA.
April 19, Informal meeting. Secy., L. V. Carmalt, Roanke, Va.

NEW YORK RAILROAD CLUB.
April 20, "Rules of Interchange of Freight Cars." Secy., H. G. Prout, 73 Broadway, N. Y.

ENGINEERS' CLUB OF CINCINNATI.
April 20, Secy., J. F. Wilson, 24 W. 4th St.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
April 20, Secy., C. F. Franson, Portland Block.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
April 20, Atlanta, Ga., Secy., F. A. Charpiot, Macon, Ga.

TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
April 21, 201 Washington Building.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
April 28, Secy., C. H. McLeod, Montreal, P. Q.

CENTRAL RAILWAY CLUB.
May 24, Secy., S. W. Spear, Buffalo, N. Y.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

We wonder how many of our readers have asked the question, Why was the design of a foreign engineer chosen for the 5,000-HP. turbines of the Niagara Falls power plant? America has certainly had in the past hydraulic engineers who won international fame by their abilities and achievements. We are loth to believe that those now at the head of the profession are any the less able to compete with the best work of foreign engineers than were those of former years. Probably the reason which is most frequently ascribed for the choice of a Swiss engineering firm's design for the turbines is that in Switzerland the greatest experience has been had in the utilization of waterfalls under high heads. But on a little consideration, this reason loses most of its force. The conditions at Niagara are so unprecedented that the Swiss engineers had no material advantage over the Americans in undertaking the problem.

In reviewing the record of the international competition under which the designs were presented, it appears in the first place that only one engineer of the five which constituted the commission was an American, and that only 2 firms of the 14 which submitted designs were American.

As the Cataract Construction Co. refuses to make public the designs submitted or the report of the commission upon them, it would be idle to say that the commission did not make the wisest choice from the plans which came before it. But every engineer is at liberty to criticise the designs which the successful Swiss firm have made, and which are now being carried into effect. We publish drawings of the 5,000-HP. turbine on our inset sheet this week, as so large and unprecedented a machine deserves record in our columns; and we believe our readers interested in hydraulic engineering will find it worth while to make a critical study of these details.

The report of the receivers as to the financial condition of the Philadelphia & Reading R. R. property, which has been expected for some time, has finally been issued, and although it is decidedly negative and evasive it affords the first reliable figures upon which to base conclusions. In regard to some of the company's transactions, especially its sensational incursions into the New England railway field, the statement gives but little definite information, but enough is given to account without much difficulty for the company's collapse. The report shows current liabilities of $18,472,828, of which $9,867,347 were notes and bills payable outstanding on Feb. 20, and $8,605,481 were other liabilities such as wages, supplies, rentals, etc. Against these liabilities are reported assets amounting to $15,779,784. But of the total assets only $29,241 consisted of actual cash and $89,996 of bills receivable. In other words, the company held only about $120,000 in cash and bills receivable with which to meet the pressing demands for wages and supplies on a great railway system, having current liabilities amounting to over eighteen millions of dollars. It would seem that here alone was sufficient cause for insolvency and receivers, not to mention the company's other financial burdens. As we have before stated, a company just emerging from bankruptcy is a very unstable base upon which to build a great railway system.

It is perhaps unfair to pass judgment upon the acts of the Reading management prior to the publication of the company's full report or a more complete statement by the receivers, but judging from present information many of them were decidedly unwise to say the least. The successive steps leading to the company's downfall are succinctly reviewed as follows by the "Commercial and Financial Chronicle":

"The managers, soon after they effected the coal combination, found themselves embarrassed by a large accumulation of coal on hand, and by heavy floating obligations—the latter, in part, the result of these accumulations, and in part the result of the greatly enlarged character of the Reading's business and operations. They could not dispose of the coal in their own territory, so they wandered off in search of a new field in New England. They had very little cash, and hence were driven to buy Boston & Maine stock, etc., on margin, depositing some of the Reading collateral mortgage and third preference income bonds to protect the purchase. This venture, however, failed to relieve them of their coal, while adding greatly to their financial burdens. Then came the time for the payment of interest on the preference incomes. The company had no money for this purpose, though the monthly statements had been made to show that the interest had been earned; hence, the managers evidently thought the payment was essential to the preservation of the company's credit. This latter was obviously a consideration of very great importance, for a huge superstructure of current and speculative liabilities had been erected on a very weak financial base, and it required dexterous management to avoid an immediate collapse. Consequently, the money to pay the preference interest was borrowed. This, unfortunately, made matters worse instead of better. The company was still in need of money, and its borrowing capacity was now exhausted. All its collateral trust bonds had been pledged, and several millions of the third preference incomes; even the coal on hand and the coal accounts were covered by a lien to the Finance Company. To be sure, some more of the third preference incomes might be put out, as their issue is not limited; but these were evidently no longer acceptable to the money-lenders. The company, therefore, found itself in the predicament where it had 1,100,000 tons of unsold coal, $18,500,000 of current liabilities, and $29,241 of cash. The inevitable could not be staved off any longer, and the managers, always quick to grasp the situation, had themselves appointed receivers."

There has been a great deal of national congratulation over the high character of the armor with which our new naval vessels are equipped; and it has been commonly felt that between nickel-steel and the Harvey process we were in a fair way to make our ships so invulnerable as to considerably minimize the risks of naval warfare to our vessels and men, and to make our small navy a match for that of nations possessing more and larger ships.

This feeling of confidence bids fair to be rudely disturbed by the fact that there is nothing to prevent other nations from following our example. England and Russia have already made extensive tests of plates treated by the Harvey process, and are quite likely adopt it, unless some other method of treatment should prove superior.

If this were all, we might still have the satisfaction of feeling that although our ships were no better than those of our neighbors, all alike were so well protected that naval combat would involve little risk to lives or vessels; but the fact may as well be faced that the armor plate makers are working against heavy odds in attempting to keep pace with improvement in guns and projectiles. The improvements which have wrought a revolution in armor plate may also work a revolution in the weapons of attack. It was some time ago proposed to try nickel-steel for guns, and an 8-in. rifle of that material is now under way. The experiment is also being tried of treating the points of projectiles by the Harvey process to make them hard enough to penetrate the surface of a Harveyized plate.

Of course foreign nations can experiment in this line as well as ourselves; and if these measures serve to increase the effectiveness of the means of attack, as seems likely, armor makers will be put to their trumps to make further improvements. In fact, they are likely to be in any event, for other improvements, such as the wire-wound gun, described in our issue of Nov. 24, 1892, and the steady improvement in explosives, are likely to greatly increase the penetrating power of projectiles. It is known, too, that many inventors are busily at work on the problem how to apply the high explosives to naval warfare, and it is probable that a few years hence will see the firing of dynamite shells as easily done as the firing of ordinary charges. It may also see some method of aerial or submarine navigation perfected which will enable a charge of explosive gelatine to be dropped upon the deck or attached to the keel of a four-million-dollar ironclad. France already has a submarine torpedo boat which has given remarkably satisfactory results, and appears to be near enough to perfection to warrant confidence in its actual serviceability in case of war. Italy and the United States are also experimenting with submarine boats which give much promise of success. Evidently, when the submarine boat becomes an available weapon, armor-clad vessels will follow the old wooden frigates which preceded them, and new methods of warfare will have to be devised, if civilization has not then progressed far enough to render war itself obsolete.

The exact racial composition of our present population, not only between native and foreign, but between the different races of foreign birth, is for the first time made known in Bulletin No. 357 of the 1890 census, which brings out vividly a fact which we have often noticed—how little the present immigration really tends to change the nature of our population, great as it is, and much as some of its constituents are with reason complained of. The following little table gives the facts in a nutshell, and distinguishes also between our white and colored native population, as it is obviously proper to do.

	No.	P. c. of total.	P. c. of whites.
Total population.....	62,622,250	100.0	.....
Less colored, native-born...	7,467,836	11.9	13.5
Total white population....	55,154,414	88.1	100.0
Or which, native-born.....	45,904,867	73.4	83.3
Total, foreign-born.....	9,249,547	14.7	16.7
British	1,251,402	2.0	2.3
Canadian	980,938	1.6	1.8
Teutonic	3,119,583	5.0	5.7
Irish	1,871,509	3.0	3.4
Scandinavian	933,249	1.5	1.7
French, Greco-Latin.....	319,822	0.5	0.6
Slavs.	510,625	0.8	0.9
Asiatics	113,383	0.2	0.2
All other.....	41,729	0.1	0.1

It will be seen that almost exactly 1-7 of our total population and 1-6 of our white population is nominally of foreign birth. But the strongest Know-nothing would hardly claim that the British and Canadian-born element is really a "foreign" one, unless it might be the French Canadians, who are known to constitute considerably less than half of the Canadian total, but who are not reported separately. With these added to the native-born element, only 11.1% (1-9) of our total population and 12.6 (1-8) of our white population can be said to be "foreign" in any sense.

But the Teutonic, Irish and Scandinavian element, aggregating 9.5% of our whole population, or 10.8% of whites only, can as little be called a "foreign" element in any true sense of the word, for they are merely an additional blend of the original racial stocks, out of which the English race was formed, in very nearly the original proportions; and if there is any truth in the analogies of history, they would (however little some of the Irishmen may like to admit the fact) merely form a new English race in all essentials, even if there were no dominating native element in which they are soon lost.

There remains, therefore, only 1.6% of our total population, or 1.8% of the whites, which can be said to be in any rational sense a "foreign" ele-

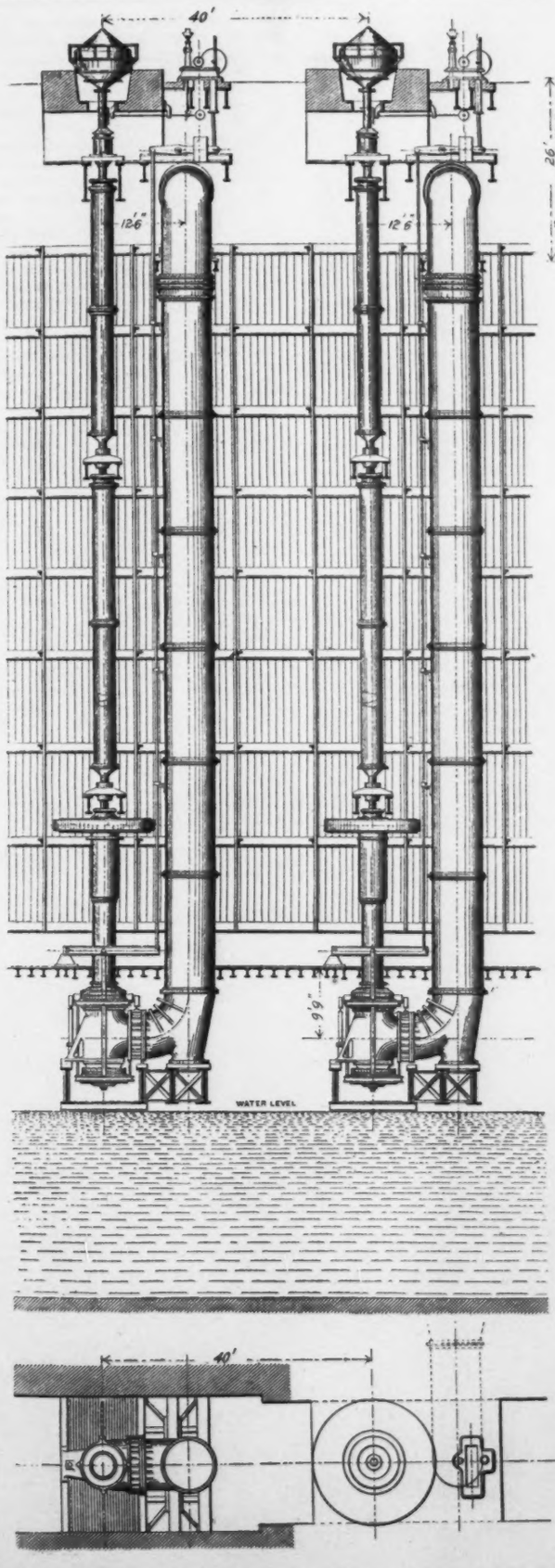


FIG. 1. GENERAL ARRANGEMENT OF TURBINES, PENSTOCK AND SHAFT.

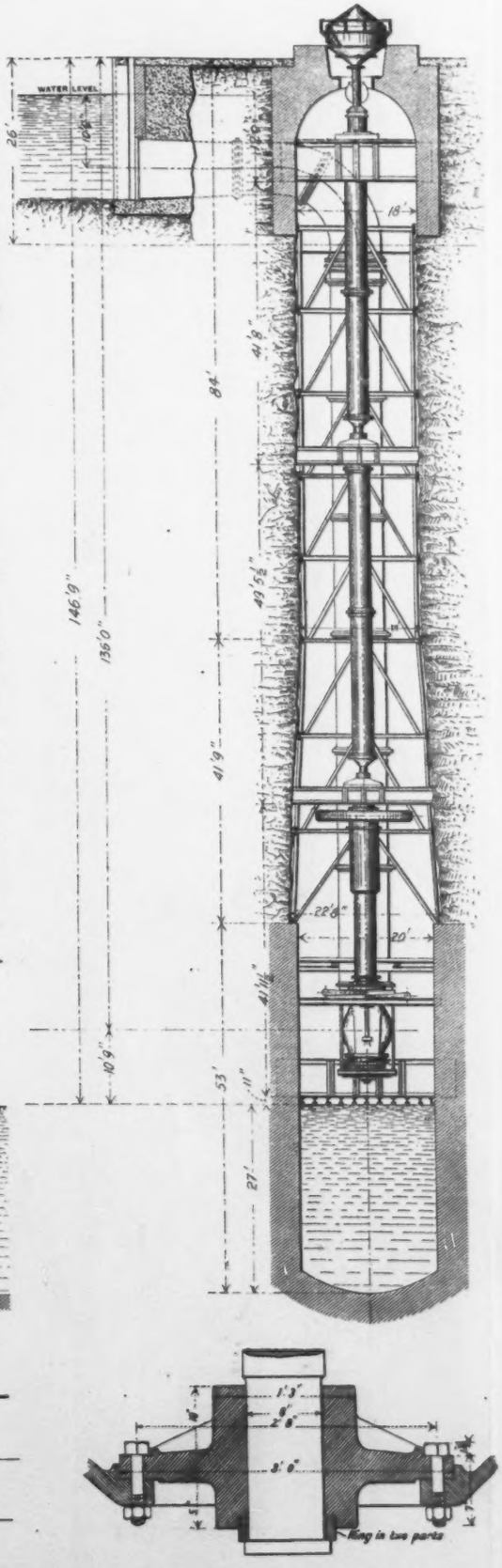
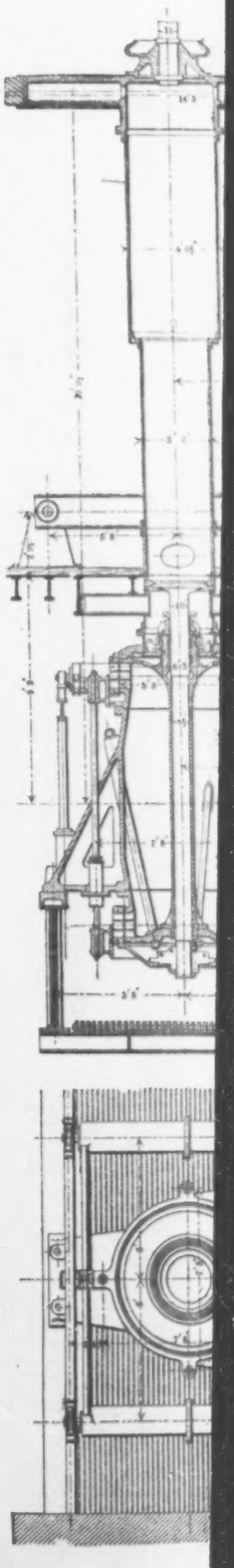


FIG. 6. SECTION AT BOTTOM OF SHAFT.



VERTICAL SECTION AND PL

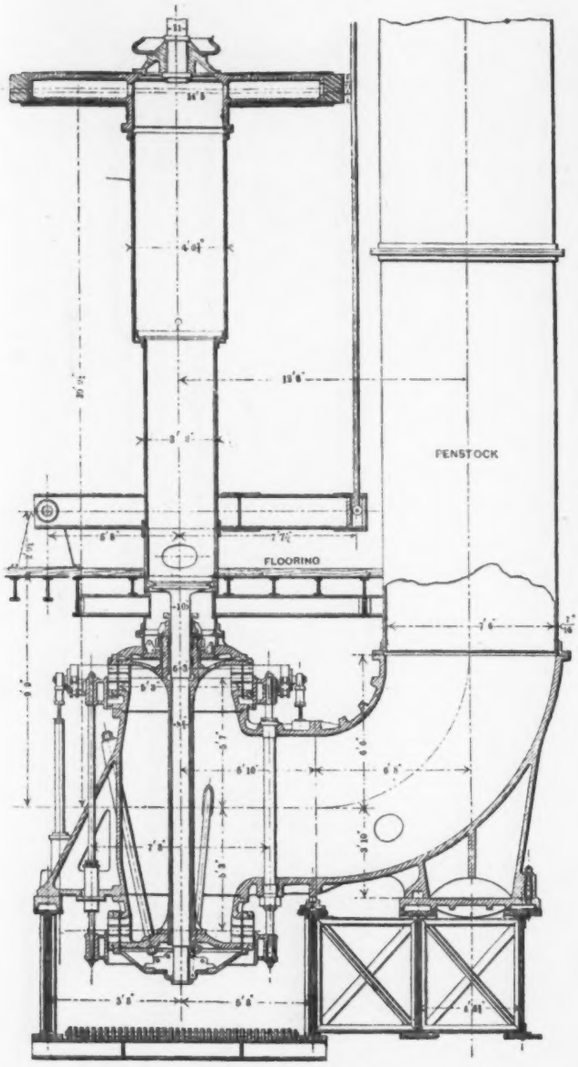


FIG. 2.
VERTICAL SECTION AND PLAN OF TURBINES AND BOTTOM OF PENSTOCK.

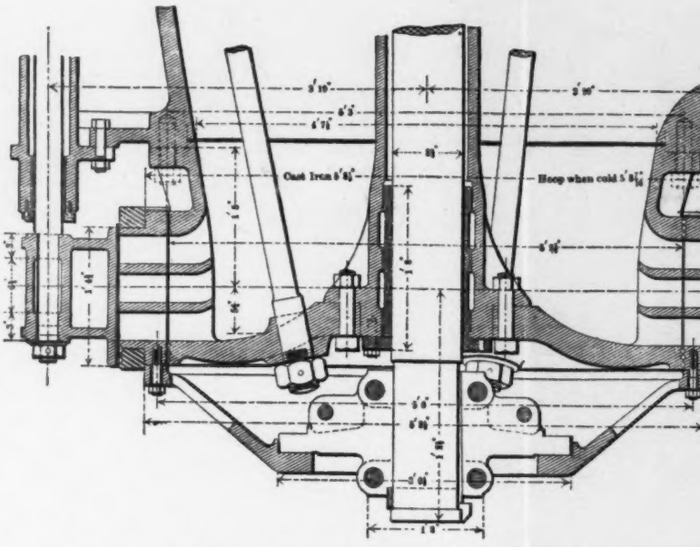


FIG. 3. ENLARGED VERTICAL SECTION OF LOWER WHEEL, SHOWING

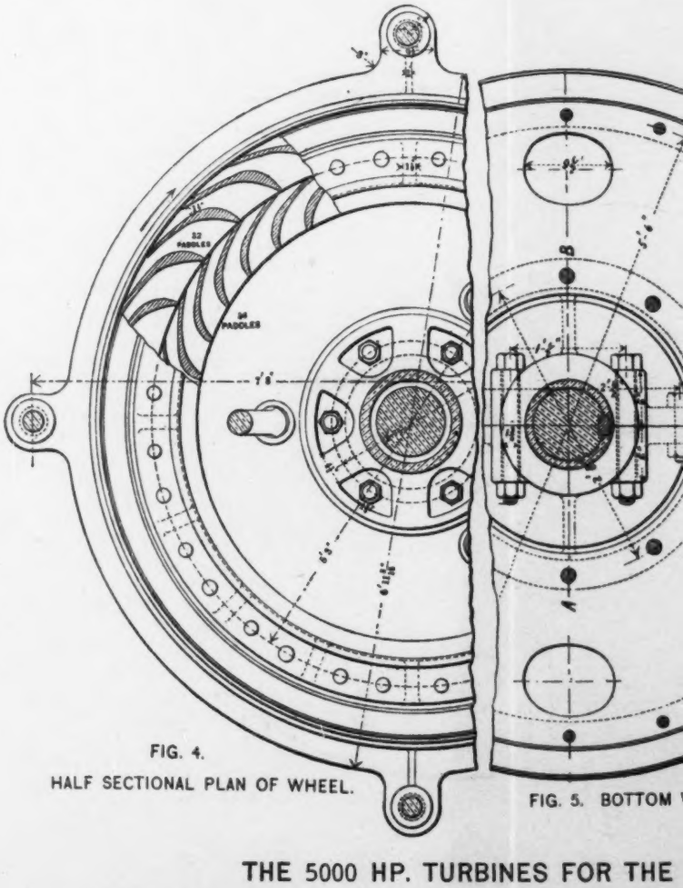


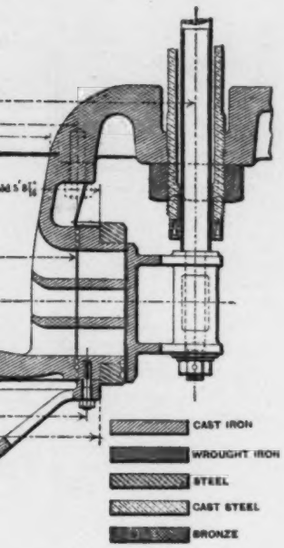
FIG. 4.
HALF SECTIONAL PLAN OF WHEEL.

FIG. 5. BOTTOM

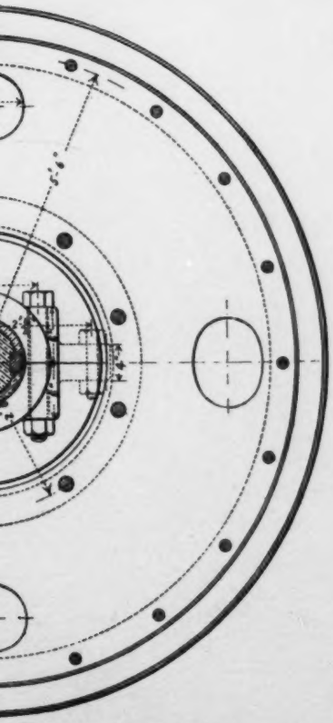
THE 5000 HP. TURBINES FOR THE
NIAGARA POWER PLANT OF THE CATARACT CONS

Faesch & Piccard, Geneva, Switzerland, Designing

I. P. Morris & Co., Philadelphia, Pa., Contra



SHOWING GATES.



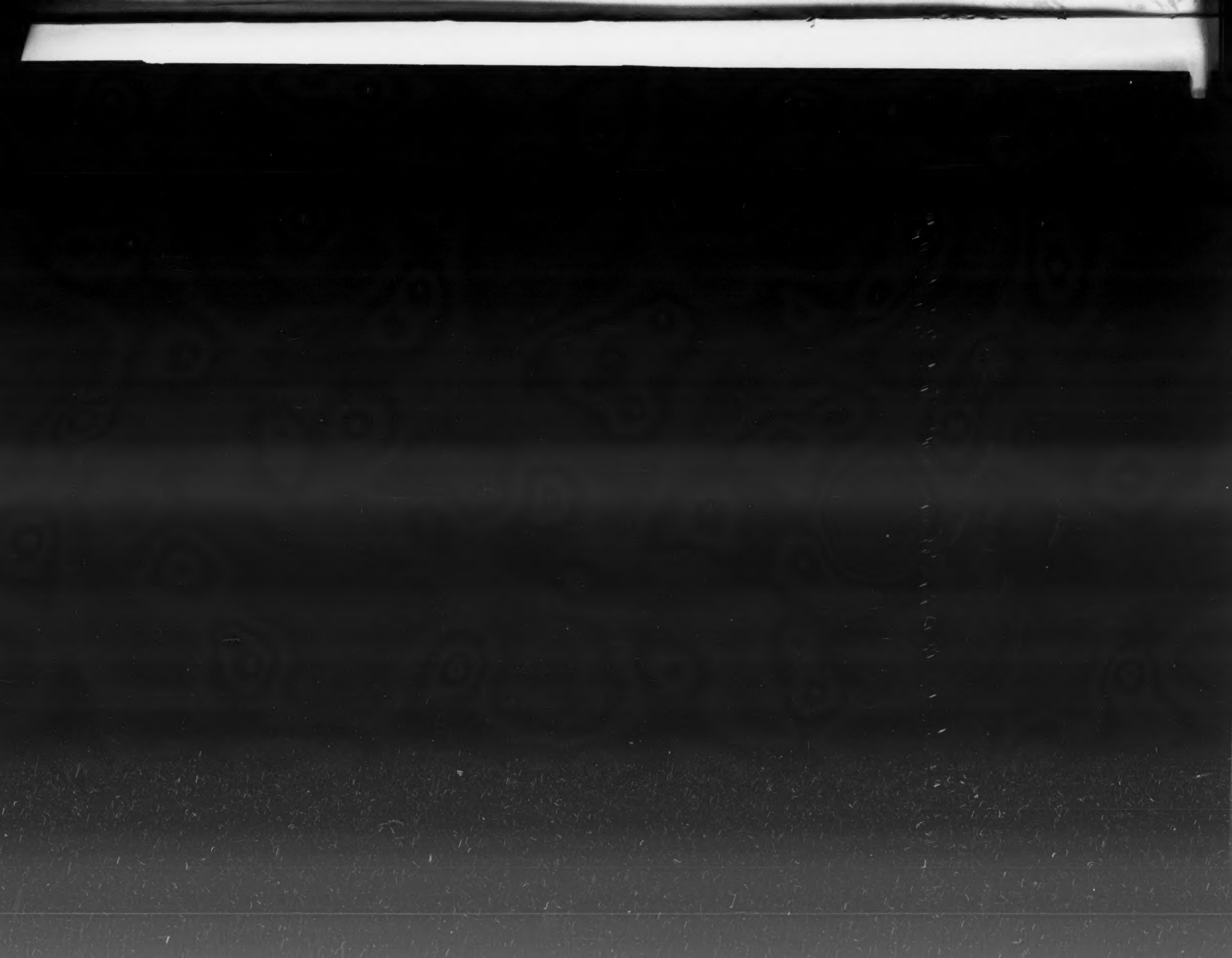
BOTTOM VIEW OF WHEEL.

OR THE
T CONSTRUCTION CO.,

Designing Engineers.

., Contractors.

HART & BONS. LITH. 39 VESEY ST., N. Y.



ment. But of these about one-third are French, Spanish, Portuguese and Italian, and who will say that even these, in such small proportion, are, any more than the others, an "alien" element? On the contrary, there was a larger proportion of these in our population of a hundred years ago than there is to-day. The remaining fraction consists of Russians, Hungaro-Bohemians, Poles and Asiatics in about equal proportions. The Asiatics are, of course, an absolutely and hopelessly alien element, but with that exception we are unable to see a single element in our population which taken as a whole we have reason to regret or to wish absent.

Nor do we believe there is any greater reason to regret the constituent elements of the fraction of each population which comes to us, nor to wish it different from what it is. There should, of course, be stringent rules, more stringent than there have been, against the admission of the vicious, diseased or shiftless emigrants; but taken as a whole, those who come here are the very best elements for our use in building a new nation and people which each of the several countries could furnish us. They do not include any large proportion of those who are doing well (enough to suit them) at home; but who are the people that make any country great, those who are satisfied with the state wherein it has pleased God to place them, or those who are not? The more ambitious, the more self-reliant, the more sturdy, resourceful and determined elements of the several emigrating peoples, are for the most part those who feel the strongest impulse to emigrate; and what better line of demarkation between the desirable and undesirable elements of any population can be drawn than this which natural selection furnishes? We fully believe that the privilege of immigration should be very much more carefully regulated, but any policy which looks toward the suppression of immigration would be, in our judgment, a mistake.

In a paper on "Fuel Gas Values," printed in our issue of Oct. 20, the author, Mr. Stephen H. Emmens, called attention to the fact that the value of some of the metric units, especially the liter, is variously given by different authorities. One of these quoted was the "Dictionary of Metric Measuses," by Latimer Clark, F. R. S. In a paper recently read before the American Association of Manufacturers and Inventors, Mr. Emmens gives a letter from Mr. Clark, in which he says that the discrepancies are largely due to authors taking the old Board of Trade or Parlimentary standards, which were considerably in error. Mr. Clark's own book was corrected to conform to the Board of Trade standard of 1890. Mr. Emmens then proceeds to show by numerous qutations from Mr. Clark's "Dictionary" that the actual values of the metric units are in quite as much doubt and uncertainty as the values of the older units of weight and measure. Different enactments by legislative bodies, errors in measurement and in calculation, difference in weights between bodies weighed in air and weighed in vacuo, and difference in weights between water containing air and water freed from it have conspired to produce these variations. It is true these variations are all so small as not to affect the practical accuracy of any ordinary measurements; but for the exact work of physicists and chemists, and for some of the finer measurements of engineers these variations are sufficient to affect the results. The moral which Mr. Emmens points is that the author of any paper or treatise claiming scientific accuracy, and dealing in quantities whose exact values may be in doubt, should preface his work with a statement of the constants adopted throughout the work.

In a personal letter to us, Mr. Emmens makes the further suggestion that the international congress of scientists and engineers at Chicago next summer will afford an excellent opportunity for defining anew the metric standards whose values have become most variable, thus restoring to the system the advantages of simplicity and freedom from ambiguity which it was originally intended to possess. It certainly gives good ground for criticism that in every school in the land pupils are taught that the liter is equal to the cubic decimeter, whereas, in reality, the liter is about 0.1 cu. in. larger than a cubic decimeter, the exact variation depending on what value is chosen for each.

THE SELECTION OF BUILDING STONE.

One of the first and most important duties the engineer in charge of construction is called upon to perform is the selection of a proper building stone; or the approval or disapproval of material offered by the contractor for work for which the engineer is properly responsible. This selection is not an easy task; it is one calling for careful investigation, experience and judgment, and no young engineer can too soon acquire at least some fair amount of knowledge upon this subject. It is too commonly assumed that because a stone looks well when quarried, will withstand a reasonable pressure, and will dress readily, it is sufficient for all purposes intended. A stone so selected may or may not meet all immediate demands; but there are certainly many other requirements in a proper building material that need close investigation, and the chief of all these is the durability of the stone under the influence of atmosphere and time, assuming, of course, that the stone will carry the load put upon it. As to this latter condition, it may be said that few stones at all suitable for building purposes fail under direct pressure alone.

Close observation of the characteristics and condition of stone that has been exposed for years in structures is one of the best methods of gathering information under this head. The gravestones in old churchyards are especially useful in this respect, for they give the time of exposure to atmospheric influence, the rate of deterioration, when this is present, and often furnish a widely contrasting range of materials subjected to singular influences. The value of a building stone is dependent upon its physical condition and its chemical composition. Under the first head comes the size of the constituent particles, its porosity and its cohesion; and under the second head we have its general chemical composition, its cementing materials and its foreign ingredients.

The general characteristics of building stone are well set forth in one of the most complete reports ever made upon this subject, presented in 1868 by Dr. Charles H. Porter to the commission charged with the erection of the proposed New Capitol at Albany, N. Y. This report is now out of print, and rarely met with, and the investigation and suggestions of Dr. Porter, as there presented, will be freely used in the matter following.

In all compound stones the different mineral elements occur in particles of various sizes. Thus, in most traps the mineral elements form a homogeneous mass and are not separately distinguishable; and in some granites the particles of feldspar, quartz and mica are so small that the stone has a fine, even grain and almost uniform color; while in other granites these particles are larger and easily recognized. Some sandstones are perfectly uniform in texture; others contain grains and pebbles of varying sizes. The marbles also differ widely in this respect; the crystalline grains being coarse or fine. These differences often seriously affect the durability of the material, and often make a great difference in the ease of working and the face finish obtainable. The general belief that coarsely crystallized stones are inferior to fine grained stone of the same character is supported by actual tests, where the average crushing weight of four coarse grained stones was 2,830 lbs., in 1-in. cubes, as compared with 5,983 lbs., the average for four fine grained stones of the same character. The ratio between the two is thus 100 to 211 in favor of the fine grained stone.

The porosity of a stone is dependent upon the arrangement of its particles; whether the stone is of a crystalline or fragmental structure; and it may be here said that even the most homogeneous and compact stones absorb some water; the difference between them in this respect is only one of degree. Traps and basalts have their particles so closely compacted together as to be free from sensible pores; while many sandstones, limestones, etc., have a porous or cellular structure, due to their loosely compacted particles. But some of the more compact varieties of marble and limestone resist the destructive action of frost to a surprising degree, and in this respect surpass many granites and most of the sandstones.

The cohesion of stones, or the firmness with which their particles are bound together, differs greatly. And in this respect it is to be particularly noted that the resistance of a stone to pressure is dependent upon its state of aggregation, rather than upon the density or hardness of its particles. For example, the silicious particles composing sandstone have a hardness of 7, and yet blocks of this stone are frequently far weaker than marble having a hardness of about 3. The resistance of a stone to wear depends upon its toughness rather than upon its hardness. This fact is recognized in the wear of paving blocks; and it is claimed that Peterhead granite, with a crushing weight represented by 1,800, will outwear, as paving blocks, six sets of Portland stone, which will withstand more than half this crushing weight, or 1,000.

The chemical components of minerals vary according to known laws; but these variations are often of great importance in judging of the general quality of the stone. Granites are ordinarily very durable; but those containing the larger proportion of alkali in the feldspar are more liable to decomposition; and the more the feldspar predominates the more liable the granite is to crumble. The true marbles are a pure crystalline carbonate of lime; but marbles containing carbonate of magnesia, or dolomitic marble, vary exceedingly in their resistance to atmospheric influence. The Southwell Church, in England, for example, was built of this magnesian limestone in the twelfth century, and in 1837 its mouldings "were as sharp as when first executed"; yet other structures, built of a similar limestone in the present century, already show signs of decay. The opinion is expressed that the nearer the dolomites approach to equivalent parts of carbonates of lime and magnesia, the more crystalline and the better the stone.

The cementing material in stone is of special importance. In the marbles and some sandstones the cement is the same as the particles composing the stone, and impart qualities of durability; while in many other sandstones the binding material is ferruginous, calcareous, or of a mixed character, and thus make it more or less easily soluble and more readily disintegrated. The hardening of certain sandstones, limestones, etc., on exposure to the air after quarrying, is a well recognized, but not yet fully explained, phenomenon. It is most probably due to both physical and chemical causes.

The foreign ingredients in stone, or those substances not essential to it, may or may not work harm by their presence. Iron particles, in a low state of oxidation, may, by the action of oxygen and carbonic acid in the air, produce a per-oxide of iron and stain light-colored stone. Iron pyrites in marble or limestone may produce sulphuric acid, under the same agency, and this reacting on the carbonate of lime will gradually cause the stone to change color and crumble. Sandstones are disastrously affected in the same way; and iron pyrites in granites and other compound stones rust the surface and usually loosen the grain and cause disintegration.

The failure of building stone is due either to physical or to chemical causes. As before said, the cases are rare in actual practice where the stone yields under a direct crushing pressure, or is subjected in ordinary masonry to a load per square foot even approaching its ultimate resistance to crushing. Thus, sandstones require a weight of from 150 to 550 tons per square foot to crush them; yet the sandstone pillars of the Church of All Saints, at Angers, which are cited as carrying one of the heavies loads imposed upon work of this character, are subjected to a pressure of about 43 tons per square foot. The piers under the dome of St. Peter's, at Rome, carry a load of about 16½ tons per foot, and the dome of the Pantheon, in Paris, imposes a load of 30 tons per square foot on its piers of Bayneaux stone. Trautwine says that to crush a 1-ft. cube of ordinary granite would require a column of the same stone 1 ft. square and 8,145 ft. high; and average sandstone would crush under a similar column 4,178 ft. high. When we compare these notable cases of heavy loading here cited with the resistance to crushing of granites, limestones, etc., as lately given in our own columns, we arrive at the conclusion that there are some other elements more worthy of investigation, in the selection of stone, than the mere qualities of strength under a crushing load. This remark is made, however, with the caution that in archwork, especially, a concentrated heavy load is possible, and will almost inevitably cause

failure unless carefully provided for. Bad stone-dressing, bad setting, the settlement of foundations and the unequal compression of mortar joints, where brick or rubble masonry is used to back cutstone, may all cause failure by the cracking of the stone or the spawling of the facejoints. But these failures are due usually to the stone being called upon to act as a beam in supporting the load, and have nothing to do with the strength of the stone as established by crushing tests.

High structures, like factory chimneys, or the Bunker Hill monument, bend and warp under the influence of varying temperatures on its different sides; but the disintegrating effect of this motion would be unappreciable were it not so very often combined with alternate freezing and thawing. Water expands as it freezes, and the tendency is to tear apart the particles of stone with a force exerted, in passing from the liquid to the solid state, at 30° Fahr., of not less than 138 tons to the square foot. Water also holds carbonic acid in solution, taken up from the air, and this solution acts energetically upon limestones and marbles or calcareous standstones. The combined destructive effect of freezing and thawing and solvent action increases in a direct proportion with the porosity of the stone, and makes plain the rule that wherever possible the denser, least porous stone should be selected for durability, under these most potent of all elements of destruction in stone.

To test the comparative durability of stone as affected by freezing and thawing. M. Brard, a French engineer, adopted a method which was afterward modified by Hericart and Shury, as follows: Cubes of the stone to be tested were boiled about half an hour in a saturated solution of sulphate of soda (glauber salt) and then suspended over cups. In drying, the salt forms crystals over the surface of the stone; these are washed off with the solution several times a day, for five days, into the cup beneath. If the stone is capable of resisting the action of frost, the crystals during their formation will detach nothing from the stone; if otherwise, small particles will drop off into the cup, and these being collected and weighed, will give the relative character as to the durability of each specimen. Prof. Joseph Henry thought this process had been too much relied upon and generally employed, and he cites the experiments of Dr. Owen as leading him to doubt its perfect analogy with the operations of nature, the effects produced partaking of a chemical as well as of a mechanical action. Professor Henry subjected specimens of stone to the action of a freezing mixture for 12 and 24 hours at a time. He found that the amount of exfoliation produced by the freezing was so small that he had to repeat the experiment many times before reliable comparative results could be obtained. The stone selected for the Capitol at Washington was thus treated 50 times, and an inch cube then lost only 0.315 oz. From these data he figured that natural freezing would exfoliate 1 in. in depth of this particular stone in 10,000 years.

As tests of this kind are exceedingly troublesome, though seemingly more reliable than by the Brard method, Professor Henry recommended the determination of the quantity of water that may be absorbed by a stone, in other words, its porosity, as furnishing a measure of the force which tends in the expansion of freezing to disintegrate the surface. The degree of impermeability of a stone is measured by the weight of water which is absorbed in 24 hours by a weighed quantity of the rock, which has previously been thoroughly dried out. Prof. George A. Koenig, of the Michigan School of Mines, and late of the University of Pennsylvania, says that if the absorption is 1% or less, the stone may be regarded as very durable, as far as weathering is concerned, and Prof. Ira O. Baker, in his "Treatise on Masonry Construction," gives the following table of the absorptive power of stone, brick and mortar, which we have reduced to percentage of weight of specimen tested:

Material.	Per cent. of absorption. Max.	Min.	Aver.
Granites	0.66	0	0.13
Marbles	0.66	0	0.33
Limestones	5.00	0.20	2.63
Sandstones	6.66	0.41	4.16
Bricks	25.00	2.00	10.00
Mortars	50.00	10.00	25.00

As a result of the foregoing remarks upon the characteristics of building stone, the following general advice may be given to the young engineer called upon to select material suitable for the purpose intended:

The stone should be hard and close and fine grained in texture, or as impervious as possible to moisture. The thinner the film of cementing material, the stronger and more durable will be the stone, and this cementing material should be of a silicious or calcareous nature; any stone into which clay enters largely should be rejected, as liable to decay rapidly under the extremes of wet and frost.

The stone to be used should be studied in the quarry, or proposed quarry; and in this connection it may be said that lichen-covered rocks are usually those of great strength and durability; for in the softer and rapidly decaying rocks the destruction goes on at such a rate that the surface does not permit the growth of vegetation of this description. It should be remembered that the solvent action of water is greatest upon rock in its natural position; as the water is usually filtered upon it through the soil, and much broader surfaces are exposed to this action than in artificial structures of stone. In this ledge examination, Professor Baker calls attention to the fact that north of the line of glacial action all the products of decomposition have been planed away and deposited elsewhere as drift-formation, and the rocks generally present a smooth and fresh appearance, with but a slight cap of worthless rock. South of this line of action, however, the same class of rocks are covered with the rotten products of long years of atmospheric action. As a rule, says Prof. James Hall, when State Geologist of New York, the soft and decomposing rocks appear in low, rounded, or flattened exposures, or entirely covered by the soil of their own debris, forming no conspicuous feature in the country. On the contrary, the harder rocks stand out in relief, producing marked and distinguishing features in the landscape. As before mentioned, one of the best sources of local information regarding the comparative durability of a prevailing rock, is to closely observe the effect of time and weathering, as seen in old buildings, bridge piers and gravestones. A durable stone should preserve its edges and corners sharp and true, and show the toolmarks after many years of exposure, and this is the case in some English structures dating back nearly 800 years, and subjected to a climate nearest approaching to our own.

A stone that has a crystalline, or fibrous structure, will resist atmospheric attack better than an amorphous stone. And while a fine grained, crystalline stone is shown to be stronger than a coarse grained variety of the same class, the finer grained material will naturally exfoliate more readily under the action of frost than the coarse grained specimen. A stone that is laminar in structure absorbs moisture unequally, and will be seriously affected by freezing and thawing; and this is particularly the case when argillaceous matter is present in the stone in seams, as in some sandstones. The graywacke, or bluestone, however, of the Hudson River and other groups of rock in New York, is an argillaceous sandstone that is hard and fine grained, and when free from seams and laid on its natural bed, it forms a strong and durable building material.

We have frequently referred to the physical agencies working destructively upon stone, but add a few more specific examples, chiefly as given by Mr. George P. Merrill, Curator of Geology in the United States National Museum, at Washington, and the author of "Stones for Building and Decoration." The amount of expansion and contraction in the particles of stone under a rise and fall in temperature is only appreciable in stone structures of considerable height. Thus, the Bunker Hill monument, a hollow, granite obelisk, 221 ft. high and 30 ft. square at the base, swings from side to side with the progress of the sun during a bright day, so that a pendulum suspended from the center of the top describes an irregular eclipse at the bottom, nearly half an inch in greatest diameter. The sides of buildings exposed longest to the sun and thus subject to the full range of atmospheric variations often show a decided tendency to disintegration after long exposure to this action. This expansion and contraction of stone also act destructively in other ways, especially in coping or covering stones. The difficulty of obtaining permanently tight joints, even with the strongest cement, led Colonel Totten, of the United States Engineers, to experiment upon the actual expansion and contraction of granite, sandstone and marble subjected to ordinary temperatures. About 30 experiments on each variety of stone showed that the rate of expansion and contraction, which seemed to be uniform for the temperatures employed, was as follows: For granite, .000004825 in. per foot for each degree Fahrenheit; for marble, .000005668 in., and for sandstone, .000009532 in. Professor Adie, of Edinburgh, found the rate to be .00000438 in. for granite, and .00000613 in. for marble. This means that two granite coping stones, 5 ft. long each and exposed to a range of 96° Fahr., would, if laid in summer, shrink .0278 in.; marble would shorten .0326 in., and sandstone, 0.549 in. under similar conditions. These minute cracks will admit water, and a repeated action of this kind must eventually crumble the cement and leave an open joint.

Sufficient and reliable data are not available for determining the comparative effects of fire upon various kinds of stone. But it is generally admitted that granite is the least fireproof of all, and that fine grained, silicious sandstones, such as are often used for fire-backs, are the least injured by exposure to excessive heat. St. Peter's Church, at Lamerton, England, lately burned, was built chiefly of granite, and was completely ruined. Yet the tower, made of a local freestone, was left intact under a heat that was sufficient to melt six of the bells that hung in the belfry.

The abrasion of building stone by flying dust and sand, the effect of lightning in the formation of nitric acid and vegetable growth upon the face of masonry are minor elements of destruction. But enough has been said here to lead the interested reader to observe and think for himself, and gain knowledge and experience by that most valued of all teachers—personal observation. In this connection, Mr. Merrill very wisely says that "after all that has been said and written, there are no tests or series of tests equal to an examination of the stone in its natural outcrops, or in buildings of long standing." He further says that were he restricted to either field examination or laboratory tests, he would, except in the purely calcareous rocks, unhesitatingly choose the field examination, provided he had good natural outcrops or quarry openings of long standing to deal with.

The Manila Ry. Co. is advertising the issue of $1,000,000 6% mortgage bonds, part of a total authorized issue of $1,500,000, subject to the charge securing the previous issue of $1,425,000. The company was organized in London, in 1888, to take over a concession for 99 years granted by the Spanish government for a railway 120 miles long, from Manila, the capital of Luzon, one of the Philippine Islands, and terminating at the port of Dagupan, on the Bay of Lingayen. The cost of building the line has exceeded the estimates received from time to time, but Nov. 23, 1892, the railway was opened for traffic throughout its entire length, having been completed according to the plans approved by the government, with the exception of one bridge over the Rio Grande, the further expenditure on which the engineer in charge estimates at $50,000. The traffic at this point is at present worked by ferry, without breaking bulk. The track, bridges, culverts, rolling stock, etc., are all in good order, and the government authorities have approved the construction of the line. Under the concession the government has guaranteed interest, payable quarterly, at the rate of 8% per annum on a capital of $24,822,000, taking the working expenses at 50% of the gross earnings. By later arrangements the amount of guaranteed capital has been increased by $1,534,025, for authorized extra works, thus making the total capital $26,356,025, with a guarantee of 8% per annum. The subsidies on account of the second section have been promptly paid when due. The guarantee on the first section will be complete on the opening of the bridge over the Rio Grande, expected in June next; and payment of the guarantee on the third section, of which the first quarter's installment is just due, has been authorized by the government. The railway was described in our issue of Jan. 26, 1889.

A water-power canal scheme known as the Hendricks canal is under way in Nebraska, the final surveys, according to reports, now being in progress. It is said that the canal will tap both the Platte and Elkhorn rivers near Gretna, Neb., and furnish electric power to Omaha, South Omaha, Lincoln and Ashland.

LETTERS TO THE EDITOR.

SEWAGE TREATMENT AND SLUDGE DISPOSAL.

Sir: In your issue of March 2, in which you notice a recent pamphlet of mine, I am described as "Engineer to the London County Council." In this country, the foregoing title is always applied to the chief engineer only—my official title is "district engineer." I am naturally anxious that there should be no misunderstanding upon this point. I shall also be obliged if you will kindly allow me to state that I have resigned my position under the County Council, and have become a partner of John Taylor & Sons, civil engineers, 27 Great George St., London. I am, sir,

Your obedient servant,

London, England, March 17, 1893. W. Santo Crimp.

STEEL RAILS ON MASSACHUSETTS RAILWAYS.

Sir: I have noticed what you call an error in the Report of the Massachusetts Board of Railroad Commissioners, reviewed in your issue of March 16, in the statement of the extent of steel rails laid by the companies reporting to the Board. But it is not an error. The extent of steel rails laid is on the whole of the roads, both within and outside the state, and it is nowhere stated that it is in the state. A closer examination of the table on p. 230 of the Report will show that the extent of steel rails laid is not given as "in Massachusetts." Perhaps the statement might be somewhat clearer; but the companies do not report steel rails in Massachusetts, or it would so appear in the table.

Yours truly,

Wm. A. Crafts, Clerk.

DANGEROUS HIGHWAY BRIDGES.

Sir: Referring to your issue of Feb. 16, Mr. C. A. P. Turner, in a communication entitled "Letting Contracts for Highway Bridges," mentions as a curiosity a pin connected bridge, built over a ditch in one of the Central states, and having a span of 22 ft. This seems to be a common style of bridge in this section, as I noticed during a recent trip over the Pennsylvania R. R. A bridge which looks like the exact counterpart of the one illustrated by Mr. Turner is being erected across the tracks of the Pennsylvania R. R. between Harrisburg and Philadelphia, and not far from Lancaster, Pa., if I am not mistaken.

Yours truly, * * * * *

Chicago, March 17, 1893.

RELATIVE LENGTH OF STEEL TAPES.

Sir: In your last number "J. W. B." requests information concerning the length of Chesterman's tapes, as compared with American standards. Two 100-ft. Chesterman tapes compared with a 300-ft. steel tape of the Mississippi River Commission, show the following results; tapes supported every 30 ft. with 16 lbs. tension:

One tape, reduced to 62° F..... = 100.0105
" " " " ..... = 100.0074

Coefficient of expansion for 1° F. for one foot = 0.00000092.

The tape of the Mississippi River Commission was standardized by measuring the Primary Lake Survey base line at Olney, Ill. For methods see Land Survey Report and Report of the Missouri River Commission for 1887.

Very respectfully, R. F. Grady.

St. Louis, Mo., March 2, 1893.

Sir: The answer made by the Keuffel & Esser Co., that the publication of the Coast Survey entitled "Tables for Converting Customary and Metric Weights and Measures" gives a full answer to my query published in Engineering News of Feb. 23, is not correct.

The query which remains unanswered is as follows: Have not Messrs. Heller & Brightly, in their "Remarks on Engineers' Surveying Instruments," made an error or an incorrect statement when they allege that the English steel tape is usually found by them about ½ in. too short in 100 ft.? (For the statement in full see p. 15 of their "Remarks on Engineers' Surveying Instruments.")

In the publication referred to by Keuffel & Esser, there is this statement: "The only authorized material standard of customary length is the Throughton scale belonging to this office, whose length at 59°.52 F. conforms to the British standard. The yard in use in the United States is, therefore, equal to the British yard."

The query is not whether the British and U. S. standards of length are equal; but whether the statement by Heller & Brightly, that the English steel ribbon tape is about ½ in. short compared with U. S. standard, is correct. The Kueffer & Esser Co. claim that the Excelsior tape made by them is correct U. S. standard. I have found that, on comparing it with the English Chesterman tape (bought from Messrs. Heller & Brightly about the time they published their statement), there is no difference in length.

Yours truly,

Pittston, Pa., March 10, 1893. John W. Berry.

Sir: In reply to your correspondent who inquires as to the length of Chesterman's tapes, I would state that tests of several have been made in my office, and they have been found to be very uniformly 0.02 ft. longer than my standard, in a length of 66 ft. Since German investigations indicate that the constant error in taping with ordinary care is about 3-100 of one per cent., and it is at times customary to allow for this by making the tape about 3-100 of one per cent. long, I have thought that perhaps Chesterman's tapes are made long intentionally.

My standard tape has been tested and marked at the Bureau of Weights and Measures, in Washington, and is correct when supported throughout, and strained with a tension of 12 lbs., at a temperature of 62° F. Under the same conditions the Chesterman tapes will be standard at about 18° F.

It is well worth the moderate fee demanded to have a tape tested at the Bureau of Weights and Measures; and every engineer doing first class work needing careful measurements should possess such a tested tape to serve as a standard.

Very truly yours,

Horace Andrews.

Albany, N. Y., March 6, 1893. City Engineer.

CURRENT METER READINGS FOR NIAGARA RIVER.

Sir: In the report of Mr. J. C. Quintus, U. S. Assist. Engr., on the discharge of the Niagara River, published in the News of March 2, I notice that, for reducing the revolutions of the meter wheel to velocities, he has used an equation in the form of $y = ax + b$ for his rating. Years ago, when current meters were crude, and their bearings not at all delicate, the points found from rating came in such a sinuous line that it was supposed (in the absence of more data) that a straight line would best fulfill the conditions; and anyone can see that this would be true if, for any speed of rotation, the friction of the bearings would remain constant. This friction, however, is not constant, but follows an, as yet, unknown law.

Now, with the delicate bearings of the modern Price meter, it is easily seen that the curve of rating departs greatly from a right line, and that an appreciable error is introduced by using the old method. I think Mr. W. G. Price, the inventor of the Price meter, was the first one to discover this.

I have seen the ratings of meters Nos. 23 and 25, and have many times rated Nos. 38, 39 and 5. In all cases the plotted points are not in a straight line. Thinking that the parabola would probably be the correct curve, I worked out equations in the form of $y = S + Tx + Ux$ by the method of least squares, from about 60 points obtained from my ratings of meter No. 38; 13 from one of meter No. 25, as well as from the points in a mean curve of seven ratings from five meters, obtained by Mr. Price. In every case the probable error of the mean was so large that I was obliged to abandon my theory.

The method now employed to a considerable extent on the Mississippi River is as follows: To plot the observed points, using the observed velocities and times as the co-ordinates, draw the most probable elastic curve through them by bending a steel straight edge, and prepare a rating table by scaling off velocities for every tenth of a revolution and interpolating between these tenths to thousandths, on a straight line.

In regard to using the mean of a number of ratings, I believe that, if the field work be done carefully and under favorable conditions, each rating should be used by itself. If to-day the meter spins four minutes from the same impulse that made it spin five yesterday the rating curves will be parallel to each other if no grit be in the bearings and the meter is in good condition; but, as the friction is different (indicated by the difference in spinning time) the intercepts on the axis of x will not be the same. However, with proper care and an instrument with true bearings the rating may be kept constant. It is best, though, to see at least once a week if this be so.

On the face of it, the first rating given for meter No. 36, $y = 4.239\,x + 0$, is absurd, for it means that an infinitesimal velocity of water will turn the wheel, or that the instrument is perfectly frictionless—a condition impossible in mundane appliances. The rating curve being convex to the axis of x (x being the velocity and y the revolutions per second), if a rating with many low and but few high velocities be obtained, and the equation of the right line established therefrom, b will be small; if a rating of many high and few low velocities be obtained, b will be large. This is probably the cause of the absurd result of the rating referred to above. For a meter in good condition it requires a velocity of from 0.1 to 0.2 ft. per second to rotate the wheel, or b varies from 0.1 to 0.2.

Very respectfully,

Thos. C. J. Bailey, U. S. Asst. Engr.,
In charge surveys, 3d District, Miss. Riv. Com.

Arkansas City, Ark., March 16, 1893.

FREE LIME IN PORTLAND CEMENT.

Sir: Mr. W. W. Maclay's judgment and criticism ("Trans. Am. Soc. C. E.," October, 1892, page 412) on my "short paper," as he terms it, are unjust and unfair. This is all the more so because his paper is not only "bristling with errors" (as he says of what I wrote), but it is a condensed error from beginning to end—done purposely or through ignorance.

I stated in my short paper, "Several well known methods of determining free caustic lime (CaO) in hydraulic cement are already at our disposal, whereby the safety or unsafety of a cement can be pronounced without any difficulty, etc." In reply to my statement Mr. Maclay gives the authority of Fresenius, who says, "As yet no method is known by which the object here stated (I suppose, determination of caustic lime) can be accomplished with absolute accuracy." Mr. Maclay does not seem to remark that the saying of Fresenius is an argument against the boiling water process, which he himself claims is the way to determine free lime.

Mr. Maclay goes further in his errors, by giving us the copies of two letters from E. Candlot and Dr. Schuman, which are as follows: E. Candlot says: "I am pleased to reply to your letter of the 9th inst. There is, in fact, no method for finding the percentage of free lime in the cement (referring to Portland)." Dr. Schuman says: "In reply to your favor of the 6th inst., I beg to inform you that I do not know a method for finding out the percentage of free lime in Portland cement. I do not think there exists such a method, and I am myself of the opinion that chemists will never find out one; the solvents (not solutions) capable of taking away the free lime from the cement will always work in a more or less strong degree on the cement itself."

The conclusions of these two letters are correct, but I do not comprehend why they are brought in as arguments against my short paper. Where did Mr. Maclay remark any proposition by me to determine quantitatively caustic lime in Portland cement? I advise him to re-read my short paper, and if he wishes to open a discussion based on scientific principles, I will always be at his disposition; but his "short" or "long" paper ought not to be a string of errors, else we will lose track of a discussion which ought to be based on sound principles. With the idea that such a discussion might do good, more than 18 months ago I gave Mr. Maclay an opportunity to discuss my short paper by sending a copy of it to him before it was printed in the Engineering News, issue of Dec. 5, 1891, suggesting that he might desire to reply to it.

Now let us see if Mr. Lesley ("Trans. Am. Soc. C. E.," Oct. 1892, page 425) was really so unfortunate in quoting my report so fiercely assailed by Mr. Maclay. I will here again state that it is a dangerous system of testing hydraulic cement for caustic lime, or for any other supposed defect of the cement, by a single reagent, such as boiling water, and that in order to detect the cause or causes of the defect, we have to resort to the several well known methods by which the safety or unsafety of a cement can be pronounced without any difficulty; the principal ones are: (1) Time of setting; (2) heat developed during the setting; (3) tensile strength; (4), change of volume of pats on glass, gaged with water at ordinary temperature, and kept in water, and in the open air; (5) put on glass kept in sea water.

All the pats will be watched carefully for change of volume, cracking, etc. If after a cement has been submitted to all these tests, it should crack or show changes of volume, a portion of the cement under examination might be hydrated with two or three per cent. of water; and if this corrects the defect, it would point to caustic lime as cause of the trouble. A cement having been submitted to these well known tests, and not showing any disturbance, might be pronounced a safe one. But even then the examination of a cement is not complete without the quantitative analysis, by which finally we will be able to find the source of the defect, especially when the analysis is coupled with the synthesis, and tests made of the reconstructed cements. Having finished these several well known methods, because I do not think to have recommended anything new, there may be added under certain circumstances to all the foregoing a microscopic examination.

Now let us follow Mr. Maclay's errors: It is hardly right for him to criticise me for his own mistakes—that is, for having stated that the pats of hydraulic cement left the glass in boiling water. In so stating, I was only following his own specification, which appear under head of "Specifications of the Dock Department," May 9, 1892, and in reply to which my short paper was written. Mr. Maclay specifies, "The cement when molded on glass must be capable of being steamed for three hours and immersed in boiling water for 48 hours without leaving the glass or showing cracks or contortions." This specification headed my short paper, and was the subject of my criticism. At this late date he has corrected his error, and criticises me for having called his attention to it; he certainly condemned

cement for this very fact, and stated to me that the cement must stick to the glass. After he discovered his errors, and errors are human, it certainly hardly seems fair to try and put the responsibility upon me.

About my statement that "pure aluminate of lime heated to about 200° F. bursts and dissolves into a powder while setting," Mr. Maclay remarks: "If this is proved, shows that the aluminate of lime must be present in some other condition in a perfect Portland cement," etc., etc.," the best French cement chemists, particularly Bonami, consider the aluminate of lime when it is present in a very basic condition, as direct source of expansion, exactly as much as free lime, and that we should have silicate of alumina and lime, which is more stable than the aluminates."

We know perfectly well, and this I have controlled by actual experiments in the laboratory, that very basic aluminates which burst and swell in water at ordinary temperature, like caustic lime, cannot produce any setting effect in hydraulic cements; but we know also that aluminates having for formula the following:

$$Al_2O_3CaO;\ Al_2O_3{}^2CaO;\ Al_2O_3{}^3CaO$$

are great factors in the setting of hydraulic cements.

As to the assertion of Mr. Maclay of the necessity to have the double salt, silicate of alumina and lime, this is a theory first emitted by Vicat, which was afterward changed by the investigations of MM. Rivot and Chatoney, who claim that the setting is due to the hydration of silicate and aluminate of lime, represented respectively in the products of the calcination by the following formulas:

$$SiO_3{}^3CaO;\ Al_2O_3{}^2CaO.$$

These investigations were followed by M. Fremy, member of the French Institute, who arrives at the conclusion that the calcination of clay and carbonate of lime does not produce a good hydraulic cement unless the proportions of lime and clay are such as to form, primo, an aluminate of lime expressed by one of the formulas:

$$Al_2O_3CaO;\ Al_2O_3{}^2CaO;\ Al_2O_3{}^3CaO;$$

second, a silicate of lime, single or multiple basic becoming gelatinous with the acids, approaching the following formulas:

$$SiO_3{}^2CaO;\ SiO_3{}^3CaO.$$

Other authorities may be, with advantage, consulted, and if Mr. Maclay has himself made some investigations in this regard to sustain a theory of his own, I will be glad to have his results, especially such as will sustain his attempt to calculate silicate of lime as monobasic only, by which theory Mr. Maclay tried to prove the excess of lime found in a sample of cement submitted for his examination, and in reference to which theory we had quite a discussion some eighteen months ago, one evening, at Mr. Maclay's residence.

About the test I made with the light-burned hydraulic cements—this was done to verify Mr. Maclay's statement that he had made several tests with this class of cements, as well as with Portland cements, and that both grades show similar action in the boiling test. The result of my experiments, published in my paper, show this to be another of Mr. Maclay's unfortunate errors.

After having carefully examined all the facts, investigations and tests made by different chemists and engineers of the water boiling test, I find that they all more or less differ in their conclusions, and in the proposed modus operandi, that Faija, one of the first promoters, condemn it now, and Candlot prefers, to the boiling water test, the old system of sea-water test, or his own, the chloride of calcium test, 40-60 chloride of calcium in one liter of water), so that I consider the boiling water test, as I did before, as an experiment which has not yet given positive proof as a test for the determination of caustic lime in hydraulic cements, and a test which therefore should not be adopted in specifications; otherwise, as we have seen already, we might expose ourselves to go back on our own proposed specification, after having rejected cements by reason of our own mistakes.

E. J. De Smedt, Chemist.

New York, March 7, 1893.

A test of a 12-in. armor plate for the "Texas" was made at the Bethlehem proving grounds on March 22. Three 250-lb. Holtzer projectiles were fired from an 8-in. gun with results as follows:

Shot,	1	2	3
Powder, lbs.	79	110	91
Initial velocity, ft. per sec.	1,678	2,004	1,385
Penetration, ins.	14	Through	15½
Projectile,	Rebounded	In backing	Rebounded

All three of the projectiles were somewhat upset, but were not broken. The points of impact on the plate were 28 ins. apart. The plate was not broken up in the least, and there were no radiating cracks from any of the shot holes, which was certainly a very remarkable result. The plate was of nickel-steel, and was forged by the Bethlehem Iron Works under its 125-ton steam hammer.

RAILWAY OPERATIONS IN 1892.

We have often taken occasion to remark upon the great value of the work being carried on by the statistician of the Interstate Commerce Commission, while criticising such details as we believed to be lacking to bring out the full value of the great mass of information collected by the commission, and are glad to again call attention to what promises to be a most valuable feature which the department has introduced in its work, and will, as we understand, hereafter continue. This is to furnish the public, thorough preliminary reports, with the results of rapid compilations of railway statistics. The first of these preliminary reports, showing the earnings and operating expenses of 462 operating railways, operating 128,350 miles of line, has just been issued. It seems hardly necessary to point out the value of this innovation. Early publication of railway statistics comes second in value only to the surety of their correctness, and their convenient and logical arrangement for a permanent basis of reference and comparison. Hitherto this has been lacking in the statistical reports of the commission which have been published from 16 to 18 months after the close of the year covered by the figures. For example, the statistical report for the year ending June 30, 1891, has not yet been published, that is, the latest figures published by the commission are two years and nine months old. As a consequence, a very considerable portion of their interest and value to the general public is lost. It is true that in the past this delay was inexcusable on account of the difficulty and time required to bring the railways to a common interpretation of accounting terms so as to allow rational comparison and classification, but this end has been so nearly attained now that it does not seem unjust to demand not only advance reports like the present, but a very much earlier final report.

TABLE I.—Earnings and Operating Expenses for the Year Ending June 30, 1892, and Earnings per Mile of Railway for the Years Ending June 30, 1889-90-91-92.

	Amount.		Per mile of line operated.				
Item	Compiled.	Estimated.	1892.	1891	1890.	1889.	Inc'se of 1892 over 1891.
Mileage	128,349.99	128,349.99	128,349	161,275	26,404	153,385	..
	$	$	$	$	$	$	$
Pass'ger service	283,528,376	301,525,819	2,309	1,962	1,918	1,956	247
Freight service	646,633,945	831,361,978	5,038	4,689	4,589	4,304	349
Other earnings from operation	20,716,637	25,634,912	161	150	165	127	11
Unclassified.	*146,974	188,991	1	....	3	3	1
Total gross earnings.	951,025,153	1,221,711,634	7,409	6,801	6,525	6,290	608
Oper. exp.	633,690,838	814,722,082	4,937	4,484	4 425	4,308	399
Inc'me fr'm operation	317,334,313	407,989,515	2,472	2,263	2,300	2,087	209

* Covers two roads making no classification of "earnings" under the several heads.

With regard to the preliminary report now before us, there is the same fault to be found. It is early only in comparison with the final report from the same source, being issued nearly nine months after the close of the year which its figures cover, and covering only 128,350 miles, or about 75%, of the total railway mileage of the country. The figures of Poor's Manual, which cover practically the same period, will not be available for some months, however, and the only others yet published (Eng. News, March, 1893) are similiarly incomplete, and, moreover, do not bear the authoritative stamp of government publication. As it is, the report deserves credit as another advance step taken by the commission in the absolution of the public from the necessity of having to rely upon private enterprise for essential facts in regard to railway affairs.

As stated before, the present report gives the income account of 462 railways operating 128,350 miles of line, or 75% of the total mileage of the country, on Jan. 1, 1893. Tables are given, showing earnings, expenses, surplus and dividends of each railway, and also the revenue and density of traffic for all railways whose gross revenue exceeds $3,000,000. The following tables have been compiled and rearranged from those given in the report.

It will be observed that Table I. shows the passenger and freight earnings and operating expenses for the 128,350 miles of line covered by reports, and an estimate on the basis of these returns for the 165,000 miles, which is accepted as the probable length of a mileage operated for commercial purposes on June 30, 1892. It further shows the increase in earnings and expenses of the year 1892 over the year 1891, and comparative statements of earnings and expenses per mile of line operated for the four years, ending June 30, 1892, 1891, 1890 and 1889. The most significant fact in this summary is the large earnings of railways for 1892, as compared with the previous year. The gross earnings of the railways of the United States for the year ending June 30, 1892, estimated on the basis of actual earnings of the roads reporting, are $1,222,711,698, being an increase of $125,950,303 over the earnings of the previous year, or an increase of $608 per mile of line operated. This increase is doubtless due, in large measure, to the fact that during the fiscal year 1891 the railways were moving the poor crop of 1890, while during the fiscal year 1892 the relatively abundant crop of 1891 provided increased traffic. It is probable that the rate of increase as shown in the above table, is a little excessive, and that the estimated earnings for the entire railway system are a little too high, owing to the fact that the roads whose earnings are included in the compilation are, on an average, of a little higher grade than the roads whose earnings have been estimated. Another pertinent fact disclosed by the table is that the increase in revenue from freight service has been proportionally greater than the increase in revenue from passenger service. The estimated increase in passenger service for the year 1892 over the previous year is $31,500,038, or $247 per mile of line, as against an increase of revenue from freight service of $91,506,671, or $349 per mile of line; or, the proportion of earnings from passenger service to total service from operations is 29.81% for 1892, as against 30.37% for 1891, while for freight service this proportion is 68% in 1892, as against 67.45% in 1891.

The interesting question to the investor pertains, of course, to the ability of railways to make payments on capital invested, and, as operating expenses are the first lien on gross revenue, any change in the ratio of operating expenses and operating income is most significant. This percentage is commonly termed the coefficient of expenses. By referring to the table it appears that this coefficient is 66.63% for the year 1892, and 66.73% for the year 1891, which indicates that the increase in operating expenses did not quite equal the increase in gross earnings; or, putting the matter more directly, the increase in gross earnings for the year 1892 is 11.48%, and the increase in operating expenses is 11.31%. This is, indeed, a slight margin on which to figure out an increase in net earnings, but so broad is the basis of railway operations that it results in an increase of $43,116,114 in net earnings for the year 1892 over the year 1891.

Table 2, in which the results of railway operations for the year ending June 30, 1892, are localized, shows that the increased prosperity which has attended the railway business has been quite general throughout the country. The best indication of prosperity, as far as general business is concerned, is found in the total gross earnings from operation. As already stated, the total gross earnings from operation per mile of line increased from $6,801 in 1891 to $7,409 in 1892, being an increase of $608 per mile of line. Accepting this increase in gross earnings per mile of line as the best criterion of modifications in traffic movement, it is found that in Group I. this increase is $409; in Group II. it is $575, in Group III. it is $822; in Group V. it is $349, in Group VI. it is $650, in Group VII. it is $353, in Group VIII. it is $399, in Group IX. it is $237 and in Group X. it is $391. The figures for Group IV. have been omitted from the summary owing to inadequate data for 1892.

The highest rate of increase in gross earnings is shown by the railways in Group III., that is, in the states of Ohio, Indiana and Southern Michigan. Group IV. comes next, and after this Groups I. and II. A comparison of the net earnings for 1891 and 1892 shows that the increase in gross earnings in nine of the ten groups has led to increases

in net earnings in five groups and decreases in four groups.

The report also gives a table showing for each of 62 railways whose gross revenue exceeds

TABLE II.—Showing Comparative Earnings and Operating Expenses for 1891 and 1892 by Groups.

(Figures for Group IV. omitted, owing to inadequate data for 1892.)

Item.	Amount. 1 = 1,000.	Per mile of line operated.	Proportion to total earnings.	Amount. 1 = 1,000.	Per mile of line operated.	Proportion to total earnings.
	Group I.					
	1892. 6,685.62 miles.			1891. 6,692.79 miles.		
Pass. service ..	$38,044	$5,691	49.01	$36,854	$5,509	49.16
Fr. service.....	38,707	5,790	49.85	37,461	5,598	49.95
Other earn.....	884	132	1.14	679	100	.89
Total gr. earn.	77,636	11,613	100.	74,985	11,201	100.
Oper. exp	54,052	8,085	69.62	52,115	7,787	69.50
Net earn.....	23,583	3,528	30.38	22,870	3,417	30.50
	Group II.					
	(a) 15 193.89 miles.			18,435.76 miles.		
Pass. service..	$68,564	$4 512	28.32	$8 ,838	$4,384	28.55
Fr. service.....	167,463	11,020	69.18	125,944	10,628	69.21
Other earn.....	2,903	391	2 47	6,344	344	2.24
Unclassified....(b)	82	5	.03	5	.....	.....
Total gr. earn.	242.103	15,931	1 0.	283.102	15,356	100.
Oper. exp.....	160,468	1 .550	66 28	152,560	9,903	64.49
Net earn... ..	81,637	5,372	33.72	100,542	5,453	35.51
	Group III.					
	(c) 16,537.16 miles.			20,996.07 miles.		
Pass. service..	$11,225	$2,492	28.55	$15,032	$2 3[illegible]	29.61
Fr. service.....	100,712	6,090	69.71	113,343	5,41	68.45
Other earn	2,475	150	1.71	3.223	154	1.94
Total gr. earn.	141,413	8,732	100.	165,599	7,910	100.3
Oper. exp	101,642	6,146	70.38	114,822	5,481	69.3
Net earn[illegible]....	42,771	2,586	29.62	50,777	2,4[illegible]6	30.67
	Group V.					
	11,252.40 miles.			16,788.47 miles.		
Pass. service...	$16,3[illegible]6	$1,450	28.43	$23,872	$1,422	29.29
Fr. service.....	40,418	3,608	69.35	55,381	3,299	67.97
Other earn.....	1,527	136	2.62	2.231	133	2.74
Total gr. earn.	58,281	5,203	100.	81,485	4.854	1 0.
Oper. exp..... .	40,358	3,601	69.24	56,179	3,347	68 95
Net earn.....	17,923	1,600	30.76	25,305	1,507	31.05
	Group VI.					
	(d) 35,863.31 miles.			37 943.10 miles.		
Pass. service....	$58,861	$1,641	27.01	$58,177	$1.533	28 26
Fr. service.....	54,995	4,322	71.14	143,.06	3,774	69.56
Other earn.....	3,971	111	1 82	4,430	117	2.15
Unclassified ...	(d) 66	2	.03	57	2	.13
Total gr. earn.	217,893	6,076	100.	205,672	5,426	100.
Oper ex..... ...	139,410	3,888	63.93	132.074	3,481	64.16
Net earn.....	7 ,482	2,188	36.02	73,797	1,945	35.84
	Group VII.					
	(e) 7,882.2[illegible] mi'es.			9,382.10 miles.		
Pass. service...	$10,342	$1.312	26.62	$12,358	$1,317	28.79
Fr. service.....	27.7-7	3,515	71.33	29,862	3,184	69.57
Other earn... .	795	101	2.05	705	75	1.64
Total gr. earn.	38,846	4,928	100.	42,926	4,575	1.00
Oper. exp.....	23,553	2,963	60.12	27,288	2,908	63 57
Net earn.....	15,942	1,905	39.88	15,638	1.657	36.46
	Group VIII.					
	(f) 13,048.01 miles.			20,268.96 miles.		
Pass. service...	$15 855	$1,215	24.98	$24,252	$1,197	26.80
Fr. service.....	44,903	3,441	70.74	62,813	3,098	69.40
Other earn.....	2,713	208	4.28	3,434	170	3.80
Total gr. earn.	63,473	4,831	100.	90,501	4,465	100.
Oper. exp	43,665	3,346	68.80	62,688	3,093	69 26
Net earn.....	19,807	1,518	31.20	27,813	1,372	30.74
	Group IX.					
	5,399.18 miles.			9,486.94 miles.		
Pass. service...	$6,428	$1,190	25.63	$10,910	$1,150	26.08
Fr service.....	18,282	3,387	72.90	30,318	3,196	72.51
Other earn.....	369	68	1.47	588	62	1.41
Total gr. earn.	25,080	4,645	100.	41,817	4,408	100.
Oper. exp	9,223	3,560	76.64	32,571	3,434	77.90
Net earn.....	5,856	1,085	23.36	9,243	974	22.10
	Group X.					
	7,094.55 miles.			11,497.85 miles.		
Pass. service...	$15,950	$2,248	35.78	$23,297	$2,026	34.39
Fr service.....	27,430	3,866	61.54	43,181	3,756	63.74
Oth r earn.....	1,196	169	2.68	1,264	110	1.87
Total gr. earn.	44,577	6,283	100.	67,743	5,892	100.
Oper. exp.....	27,484	3,874	61.66	43,101	3,749	63.62
Net earn	17,093	2,409	38.34	24,641	2.143	36.38

(a) Includes 593 miles in Group III. (b) Includes one road, making no classification of earnings under separate heads. (c) Includes 65 miles in Group IV, and 848 miles in Group VI. (d) Includes 837 miles in Group III., 325 miles in Group VII.; excludes figures for Northern Pacific R. R. (e) Includes 675 miles in Group VIII. (f) Includes 797 miles in Group IX.

$3,000,000, the mileage and gross earnings in 1892, and the gross and net earnings, and passenger and freight mileage per mile of line operated. The gross revenue of these 62 roads is $794,478,631, or 64.99% of the total estimated revenue from all the railways of the country. Estimating the remaining roads belonging to this class on the basis of the returns of last year, the report states that the total gross revenue of the 80 roads would be $1,003,724,033. Of these 62 roads there are 11, if we include the Canadian Pacific, each of which enjoys an income exceeding $20,000,000. These are as follows, given in the order of their gross earnings:

	Gross revenue.
Pennsylvania R. R.....	$68,260,901
Southern Pacific Co.....	47,480,982
New York Cen. & Hudson R. R. R.....	44,841,788
Chic., Mil. & St. Paul Ry.....	32,419,306
Chicago & Northw'n Ry.....	32,064,757
N. Y., Lake Erie & W'n R. R.....	31,692,912
Chic., Bur. & Quincy R. R.....	31,223,850
Northern Pacific R. R.....	24,911,636
Lake Shore & Mich. So. Ry.....	22,559,905
Del., Lack. & W'n R. R.....	21,761,986
Canadian Pacific Ry.....	21,032,120

A more significant figure, however, than gross revenue is gross earnings per mile of line. The average for all railways is $7,400. Of the roads in the above summary there are 31 whose earnings per mile of line fall below this general average, their large gross earnings arising from the extent of

Subdivisions of the United States Adopted by the Interstate Commerce Commission.

line operated; of the remainder, 13 have earnings varying from $7,443 to $13,000 per mile of line, 10 earnings varying from $13,000 to $20,000 per mile of line, and 8 earnings in excess of $20,000 per mile of line. These 8 are as follows:

	Gross revenue per mile of line.
Del., Lack. & W'n R. R.....	$27,607
Pittsburgh & Lake Erie R. R.....	26,379
Pennsylvania R. R.....	25,866
Boston & Albany R. R.....	25,376
New York, Prov. & Boston R. R.....	23,159
N. Y., New Haven & Hart. R. R.....	22,654
Central R. R. of N. J.....	21,669
New York Cen. & Hudson R. R. R.....	21,266

A study of the density of freight and passenger traffic for the three years covered by the table shows that the railways of the several parts of the country have not, during this period, been influenced by the same commercial conditions. In general, it may be said that the lines recovered in 1892 the ground lost in 1891, and have a slight balance to their account. The roads most affected by the increased crops of 1891 are those lying in the territory east of Chicago and north of the Ohio River, that is to say, the great trunk lines. Thus, the density of freight traffic for the lines in Group II., which in 1890 was 1,900,295 ton-miles per mile of line, and fell in 1891 to 1,763,330 ton-miles per mile of line, rose in 1892 to 1,935,404 ton-miles. The same movement is observed by turning to the density of freight traffic for the railways in Group III. So far as the trunk lines are concerned, then, they may be said to have recovered in 1892 the ground lost in 1891. Passenger traffic during the three years under consideration shows for these railways a slight increase, but in this respect the result is not as satisfactory as in the case of the railways in the New England group, where the relative increase in passenger traffic is much greater. The influence of the poor crops of 1890 and the good crops of 1891 is also seen in the density of freight traffic on the lines lying west of Chicago; that is to say, the lines classified under Group VI.

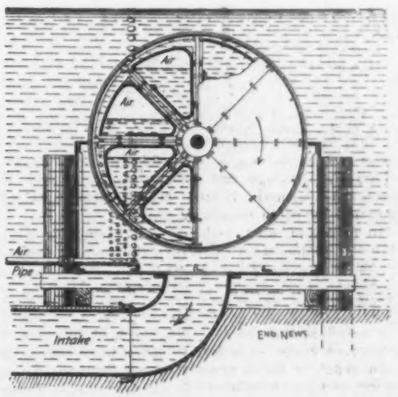
In Group V., which embraces the states of Kentucky, Tennessee, Mississippi, Alabama, Georgia, Florida and that portion of Louisiana lying east of the Mississippi River, there is a continuous increase in the density of traffic since 1890. Thus, the freight mileage per mile of line in 1890 for this group was 394,096, in 1891 it was 405,905, and in 1892 it was 490,926. Passenger statistics show a falling off in the year 1891, as compared with the year 1890, but the year 1892 shows a marked increase.

THE FALCON ROTARY STRAINER FOR WATER-WORKS INLETS.

We illustrate herewith a novel strainer, intended to prevent the stoppage of water-works inlet pipes by anchor ice, invented by Joseph G. Falcon, of Evanston, Ill., and in use at Evanston, Ill., in Lake Michigan; Metropolis, Ill., in the Ohio River; and Paducah, Ky., in the Tennessee River.

The strainer consists of a cylindrical screen mounted on an axle so as to revolve freely in a rectangular box built over the mouth of the pipe. The accompanying cut shows a sectional view of the box and the cylindrical strainer. To cause the cylinder to rotate, buckets are attached to its radial arms, with their mouths opening downward. A pipe from the shore delivers compressed air underneath the strainer at such a point that as it rises it will enter the buckets, displace a portion of the water, and exert a lifting force upon them. As each bucket rises it is gradually inverted and its charge of air escapes.

At Evanston the intake is subjected to the full force of the ice and waves, being located 2,800 ft. from the shore, at the end of a 30-in. cast iron pipe. The strainer is 12 ft. long and 7 ft. in diameter. It was placed in operation in the fall of



The Falcon Rotary Strainer for Excluding Anchor Ice From Water-Pipe Inlets.

1891, and has worked without interruption ever since, with the exception of one hour, when the air pipe on shore was frozen.

Mr. Thomas L. Davis, Superintendent of the Metropolis, Ill., water-works, in a personal letter to us states that the Falcon strainer on the intake at that place gives excellent satisfaction.

Mr. Falcon is just about building a rotary strainer 16 ft. × 7 ft. for the 36-in. intake of the supply pipe to the Washburn & Moen Mfg. Co.'s works at Waukegan, Ill. The compressed air will be furnished by a compressor with 8-in. steam cylinder, 10-in. air cylinder and 12-in. stroke. A 2-in. lead pipe will convey the air from the shore to the intake, which is 1,728 ft. out in the lake. Mr. Falcon states that the supply at these works has been cut off a large part of the winter by anchor ice, and that at Evanston there was never a winter in which the anchor ice did not cut the supply off more or less of the time until the strainer was applied to the intake.

Several failures of buildings under construction have occurred in Chicago recently, some of which have been noted in our columns, and it is proposed to pass an ordinance giving greater power to the Building Department, as building and the demolition of buildings have been carried on without due authority. Much of the trouble is said to be caused by owners persisting in having the work carried on through the severe winter weather, and in leaving the contractors to carry on the work without supervision by an architect.

THE CONSOLIDATED CAR HEATING CO.'S ELECTRIC STREET CAR HEATER.

Within the past two or three years electric heaters for cars on electric railways have come into quite extensive use. While these heaters are from one point of view very wasteful appliances, utilizing not more than 3 to 5% of the heat of the coal burned, the very small quantity of heat which is required in ordinary street car service, and the convenience of the electric heaters, compared with the stove, with perhaps also the fact that their current consumption is not generally understood, have conspired to bring them into considerable popularity.

The street-car stove has never secured the hold on the affections of street railway managers which the "deadly car stove" obtained in steam railway service. The street-car stove takes up one good sized seat, and makes the adjacent seats on each side decidedly torrid. It is such a small affair that it is troublesome to clean, feed and regulate. The ashes and coal dust play havoc with the upholstery, and occasional periods of smoking and overheating are apt to do more or less damage to the car interior. A good many street railway managers have solved the problem by not heating their cars at all, but while this may do in southern latitudes, or even as far north as Philadelphia, provided the patrons are sufficiently docile, in the northern United States street cars must be warmed by some means or other.

In principle, electric heating is simplicity itself. All that is necessary is to turn the current through a circuit of wire of a size which will offer resistance enough to the current to heat the wire to the desired temperature. A switch by which the circuit from the trolley wire through the motor may be passed through the heater completes the apparatus.

In practice there are numerous features of importance to be considered in electric heater design. A good electric heater must be readily adjustable to correspond with variations in the weather, must be safe against burning out under the heaviest currents, and must be so located as to warm the car evenly without danger of burning the clothes of passengers or any part of the car.

The Consolidated Car Heating Co.'s electric heater consists of a galvanized iron wire coiled in a spiral, and this spiral is wound in a spiral groove upon a porcelain insulator, as shown in Fig. 1. Each of these heaters is 30⅝ ins. long, 8⅞ ins. high, and 6¾ ins. wide. Upon it is wound 625 ft. of spirally coiled wire. The total weight of the whole is 23½ lbs. To prevent anything coming into contact with the wire, the whole is inclosed in a wooden case lined with asbestos mill board, with a screened opening in front, as shown in Fig. 2, by which the warm air from the heater is circulated. It is claimed that the galvanized wire will not oxidize when heated, and so gradually increase the resistance of the wire, as happens with unprotected iron wire. In case it becomes necessary to replace a resistance coil, however, it can be done in a few minutes, and without removing the heater from the car.

Each heater is designed to absorb two amperes of a 500-volt current. The six heaters which are the complement for an ordinary electric car, will therefore, take 12 amperes when all are connected. For ordinary weather, however, the heaters may be combined by the switch in different ways, so that five different intensities of heating surface are possible, besides the position in which no heat is generated, the current being turned entirely off. The switch by which these changes are made is entirely automatic, and is so arranged, moreover, that it cannot be thrown when the current is turned on. Thus the regulation of the heater can be done by the motor man or conductor, or any employee, even if unfamiliar with electrical apparatus.

Concerning the energy consumed and the cost of heating, the Consolidated Co. deserves credit for its plain statement that the amount of current used by any electric heater depends entirely on the amount of heat given off. Thus, so far as efficiency is concerned, one electric heater is as good as another, and the absurdity of the claims of "high efficiency," and "small current consumption" made by some of the manufacturers of electric heaters is self-evident.

As to the current required for heating an ordinary electric car, the Consolidated Co. states that from 2 to 12 amperes on a 500-volt circuit generates sufficient heat. With the outside temperature at 20° to 30°, about 6 amperes of current will suffice. With zero or lower temperature, the full 12 amperes of current is required to heat a car effeceively.

It is interesting to compare these figures with the experience in steam heating of railway cars, as follows:

1 B. T. U. = 0.29084 watt-hours.

6 amperes on a 500-volt circuit = 3,000 watts.

3,000 ÷ 0.29084 = 10,315.

Thus, a current consumption of 6 amperes will generate 10.315 B. T. U. per hour.

In steam-car heating, a full size passenger coach usually requires from 60 lbs. of steam in freezing weather to 100 lbs. in zero weather per hour. Supposing the steam to enter the pipes at 20 lbs. pressure, and to be discharged at 200° F., each pound of steam will give up 983 B. T. U. to the car. Then to get the equivalent of the thermal units delivered by the electrical heating system in pounds of steam, we have 10,315 ÷ 983 = 10½ nearly.

Thus, the Consolidated Car Heating Co.'s estimates for electric heating provide the equivalent of 10½ lbs. of steam per car per hour in freezing weather and 21 lbs. in zero weather. This is between one-fifth and one-sixth as much heat as is required for a full sized passenger coach, which exposes roughly some three to four times the surface of an electric street car. The difference in size alone of the two cars is not sufficient to explain the difference in radiating surface; but it is to be remembered, in addition, that the proper temperature to which a street car should be heated is at least 10° below the proper temperature in a steam railway car. Bearing this in mind, it appears that the heat supply for electrically heated cars corresponds fairly well with experience in electric car heating.

Concerning the cost of electric heating, aside from the first cost of the heaters themselves, which is a small item, the Consolidated Co. estimates the expense at ½ ct. to 3 cts. per car per hour, charging only the cost of developing the additional power required to furnish the additional current which the heaters consume. The variation will really be much greater than this, depending on the variable cost of power in different localities. The above statement is based on a cost of ½ ct. per K-W. hour. This corresponds to $18 per K-W. per annum, reckoning a service of 10 hours per day for 360 days per annum, or $13.43 per HP. per annum (of 3,600 hours). These figures seem to us exceedingly low. If an electric railway central station has at all times surplus power which costs it less than $15 per HP. per annum to generate and deliver in the form of electrical energy, it ought to be able to make large profits by selling current to stationary electric motors. Perhaps roads having a surplus of water power to drive their dynamos, or having very cheap coal at their doors, can come down to such a figure as the cost of electric heating, but most roads ought to use a higher figure in their estimates.

A road operating 20 cars, for example, and using an average of 250 HP. for their propulsion, will at 6 amperes current consumption per car for electric heating add 80 HP. to the load on its power station and circuits. In zero weather 12 amperes will be required, and the total load will be increased from 250 to 410 HP. So large an increase in the load on the station must mean something more than a mere increase in the coal bill. Of course, if a road is located far enough south to require a small amount of heat in its cars, the case for the electric heater becomes more favorable.

From the above computations a convenient rule for roughly computing the cost of electric car heating can be deduced. We have seen that ½ ct. per K-W. hour is equivalent to about $13.43 per HP. per annum. Hence 1 ct. per ampere-hour (on the ordinary 500-volt circuit) corresponds to about $40 per HP. per annum, measured at the dynamo pulley. Then the cost of electric heating per car per hour in cents equals the cost of power in dollars per HP. per annum, divided by 40 and multiplied by the number of amperes of current required.

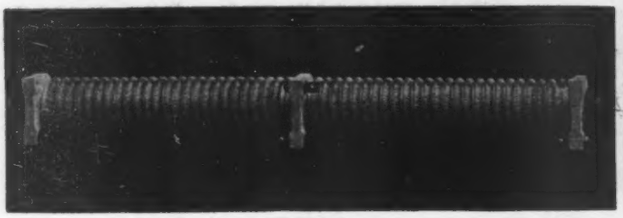


Fig. 1. View of Resistance Coil Wound on Porclain Base.

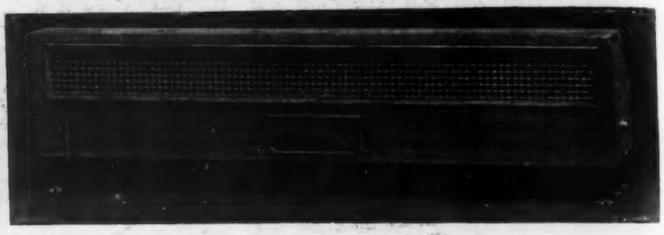


Fig. 2. Exterior View of Heater.

THE CONSOLIDATED CAR HEATING COMPANY'S ELECTRIC STREET CAR HEATER.

PROGRESS OF WORK ON THE BUSK TUNNEL, COLORADO.

Work on the Busk tunnel, through the Saguache Mountains of the Continental Divide on the Colorado Midland Ry., is making very fair progress, notwithstanding the bad character of the material penetrated. Brief descriptions of the tunnel and the plant used in its excavation, and figures showing the progress of work, were given in our issues of Jan. 17, 1891, and Aug. 25, 1892. It is being built by the Colorado Midland Ry., on its line between Busk and Ivanhoe, Colo., and will save about 530 ft. in elevation, seven miles in distance and 2,000° in curvature. It is 9,393 ft. long, and its section is 15 × 21 ft. Work was begun on the approaches Aug. 1, 1890. At present 7,422 ft. of heading and 7,164 ft. of bench have been excavated, leaving 1,971 ft. of heading and 2,229 ft. of bench to be taken out.

A recent report to us states that the work is in the same class of material it has been in from the outset, a species of gray granite, sometimes extremely hard, and at other times soft and treacherous; sometimes perfectly dry, at other times carrying large quantities of water. A comparatively small portion of the tunnel has been in material of such character that it could be left without timbering; the necessity of timbering being due to the broken condition of the rock in that portion of the tunnel where it has been hard and flinty. In other portions it has been necessary to timber because the material disintegrates on exposure to the air, and unless it is timbered will fall from the roof and sides of the tunnel in pieces varying from the size of a marble to a cubic yard. The progress varies with the character of the material and the force the contractor is able to keep on the work. When the tunnel is dry no difficulty is experienced in keeping a full force of men on the work, but when it is wet large numbers of men leave, and it is very hard to secure a sufficient number of new men to make up for the desertions.

The following table shows the total heading, bench and tunnel driven at both the Busk and Ivanhoe ends up to March 1, 1893. In figuring the number of feet of tunnel driven per month the

heading is counted as one-half the tunnel and bench as one-half. The total tunnel driven is found by adding the two together and dividing by two.

	Heading, ft.	Bench, ft.	Average ft.
Busk, end	3,918	3,792	3,855
Ivanhoe, end	3,314	3,212	3,263
Total	7,232	7,004	7,118

The monthly progress since the beginning of the excavation in September, 1890, has been as follows:

		Ft.			Ft.
September,	1890	27	December,	1891	241
October,	"	149	January,	1892	282
November,	"	280.5	February,	"	217
December,	"	286.5	March,	"	143
January,	1891	308.5	May,	"	268
February,	"	298.5	June,	"	186
March,	"	284	July,	"	217
April,	"	300	August,	"	260.5
May,	"	335	September,	"	207.5
June,	"	273	October,	"	273
July,	"	255	November,	"	268
August,	"	214	December,	"	189
September,	"	235	January,	1893	226
October,	"	247	February,	"	211
November,	"	241			
Total					7,118

For the first fifteen days in March the progress was 175 ft. It will be seen that this last progress for 15 days in March is an average of 11.66 ft. per day. The progress in detail is 6.33 ft. at Busk and 5.33 ft. at Ivanhoe. This is the largest average progress that has been made on the tunnel since the work commenced.

The work is being done under the supervision of Mr. B. H. Bryant, Chief Engineer of the Busk Tunnel Ry. Co., with headquarters at Colorado Springs, Colo.

THE RECENT SURVEY OF ST. LOUIS, MO.

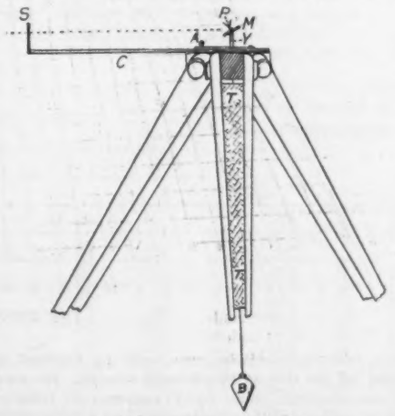
In the January issue of the "Journal of the Association of Engineering Societies," is a thoroughly practical paper on "The Recent Survey of St. Louis," by Mr. B. H. Colby, First Assistant Engineer in charge of surveys in the Sewer Department of St. Louis, Mo. The paper is full of valuable matter relating to triangulation, precise leveling, etc., and while we refer those interested to the paper itself, which is too lengthy for reproduction here, we make a few abstracts of the points of particular interest. Some notes on the survey will be found in our issues of Aug. 18 and Dec. 22, 1892.

The survey referred to was authorized in March, 1889, and was made primarily for the purpose of perfecting plans for the drainage of the city. Mr. Robert E. McMath, M. Am. Soc., C. E., then Sewer Commissioner, was father of the ordinance authorizing this survey, and he inaugurated the careful methods upon which they were carried out. In this too rare case of political office-holding, the judgment and experience of an able engineer were substituted for the mere executive ability of a party office-holder, with marked advantage to the community. Three distinct, but interlocking and combined surveys, were made, of a trigonometrical, hypsometrical and topographical character.

Mr. Colby first takes up the triangulation, and for this purpose the base line established by the government in 1882, for triangulating the Mississippi River, from Cairo to the mouth of the Illinois River, was adopted. The same survey of 1882 also established the astronomical determination of azimuth, latitude and difference of longitude. There were three government stations and two triangle sides lying wholly within the limits of St. Louis. Mr. Colby then refers to the difficulty in evenly distributing, locating and preserving triangulation stations in a city. The public parks, school house grounds, engine houses, police stations, hospitals, water-works, streets, alleys and cemeteries were utilized for this purpose.

The four different instruments used in triangulation were: A Gambey transit, No. 2, with 8 in. limb, reading to 5 seconds; a Fauth theodolite, with 8 in. limb reading to 10 seconds; a transit and a theodolite, made by Buff & Berger, both provided with 8 in. limbs reading to 10 seconds. Only 45 angles were read with the Gambey instrument, the rest of the work being about equally divided among the others. As many of the observing stations fell upon roofs, and the conditions required an average closure per triangle of less than 4 seconds, the author exactly describes his method of house-top triangulation. To use these stations at all, the repetition method of reading angles is necessary. Without entering into the detail of this description, it is sufficient to say that four "sets" of observations, two positive and two negative of five repetitions each, were taken for each angle, or the equivalent of 40 single measurements of each angle. At the present time an area of about 27,771 acres has been covered by the triangulation, with 87 stations, or about two stations to each square mile. In 85 triangles all the angles were read with an average closure per triangle of 3.7 seconds; in other words, the angles have been measured with an average error of 1.2 sec. per angle. With three or four exceptions, the triangles all closed small; which accords with the usual experience of observers measuring angles by repetition. Mr. Colby suggests the following explanation of this tendency: The repeated unclamping, turning in azimuth and reclamping of both upper and lower motions of instrument, almost invariably throw the limb slightly out of level, and when the limb is not level, every movement of a horizontal angle must be too small. The author describes the special notebook used for this survey, the manner of recording observations, and the computation of triangles. The longest line in the system was 12,803.065 metres, or 7.96 miles; the shortest line was 628.6 metres. The average length of the triangle sides was 3,104.6 metres, or nearly 2 miles.

During the fieldwork much delay was occasioned by smoke. Round targets, 8 ft. long and 1¼ in. diameter, were used in the first half of the survey. Each alternate foot was painted black and white, and each tangent was accurately plumbed and held in place by small tripods made for the purpose, at a cost of $2 each. Finally, the smoke became so great that the target tripods were all rigged out with heliotropes, and pole targets were abandoned. One leg of each tripod was fitted with a V-shaped board, painted white to be used as a target when there was no sun. This leg was always plumbed on line to the observer, and a strip of black cloth



Heliotrope Used in the St. Louis Survey.

was fastened behind it for a background. The upper part of the tripod was also painted black for the same purpose. The essential features of this tripod are shown in the cut, which for purpose of illustration shows the arm C at right angles to its proper position. The mirror M is mounted on a U-shaped support Y revolving on a vertical axis, which is plumbed over the geodetic point, the plumb-line being attached to its base. The mirror also revolves on a horizontal axis P. At the end of the arm C is the pasteboard screen S, furnished with slides having apertures of varying dimensions. An eye-screw A regulates the force required to turn the mirror upon its vertical axis. In the one leg of the tripod is the V-shaped board T T, before referred to.

To adjust it so as to send a ray of light over any line, proceed as follows: First, plumb the mirror over geodetic point, with the arm C approximately on the line over which the flash is to be sent. Then turn the mirror to a horizontal position, sight over its center to the mark and bring the aperture in the screen in line with mirror and mark. To do this exactly, however, it is best to stand with your back to mark, and looking in the mirror move the screen into such a position that you see the mark and the center of the aperture both in the exact center of the mirror. It is now only necessary to turn the mirror into position to throw the sun's reflected rays through the aperture, and keep it in this position as the angle changes. A mirror 1 in. in diameter and ¼-in. hole in the screen were used in this survey. The average closure of all triangles when targets were used was 4.6 sec.; with flashes the average was 2.7 sec.

Mr. Colby then takes up the subject of precise leveling as here performed, and truly says that among average engineers very little is really known of this branch of engineering. The methods followed in St. Louis were identical with those commonly used by the U. S. assistant engineers under the War Department, but they differ somewhat from those of the Coast Survey. The precise level used was made by Fauth & Co., of Washington, D. C., and the outfit delivered in St. Louis cost $550. The telescope has a 1½-in. aperture, 16 ins. focus, and two astronomical eye-pieces, magnifying 40 and 60 times, respectively. The micrometer screw for raising or depressing the telescope is made with the utmost exactness, and provided with a graduated head; the level can thus be used as a gradientor. The striding level is chambered, and one division equals 3 sec. of arc. The 5-in. horizontal circle is divided on silver and reads to 30 sec. The center is of steel, with clamp and spring tangent motion.

The leveling party consisted of one observer, one recorder, two rodmen, one benchcutter and one umbrella holder. Two large wagon umbrellas were always used; one to protect from the sun and the other from the wind. Precise benches to the number of 743 were established; or an average of 12 per square mile. The total distance leveled, in duplicate in opposite directions, was 240 miles. If the difference in closure exceeded 0.0208 ft. into the square root of the distance in miles, the stretch was run over twice more in the same manner, until a closure was obtained coming within this limit. In all, only 31 stretches were outside of the limit, and were re-run. The average difference of closure was 0.009 ft. per mile; the average difference of closure per stretch was 0.003 ft. The average length of stretch was 484 metres. The probable error in determination of a single mile of work is 0.001 ft. The average distance between benches in the 56 miles was 394 metres, with 4.7 settings as the average between benches.

All of the topographic work was done upon true azimuth; that is, every horizontal angle made to locate a point was the angle that the line from the instrument to the point made with the true meridian. Mr. Colby describes this method of carrying azimuth in detail, and also his method of conducting his stadia work. The entire paper has been republished by Mr. Colby, and we recommend our interested readers to obtain it in full. It is one of the most valauble and practical treatises on a survey of this nature that we have seen.

STANDARDS OF LINEAR MEASURE.

In the January issue of the "School of Mines Quarterly," Mr. Edwin P. Clark, E. M., publishes the first part of a very interesting and complete paper upon the probable origin of standards of linear measurement, from which we make the following brief abstract:

Mr. Clark says that there can be little doubt but that all measures of length were originally derived from parts of the human body; and as they are generally larger than the average length of the respective parts from which they were taken, it is fair to presume that they had their origin in the body of some leader or chieftain, who, in accordance with ancient custom, was above the average of his followers in physical as well as in mental strength. That this source of linear length is not a matter of the very remote past is proved by the rules laid down by Jacob Koebel, in his work on surveying, published in 1550. He tells you to take 16 men, big and little, as they come from the church door on Sunday, and then to make them put their left feet in line, toe to heel. The length thus obtained is a "right and lawful rood" to measure and survey land, and one-sixteenth part of this length is "a right and lawful foot."

The distance from the point of the elbow to the end of the middle finger seems to have been the original "cubit," the most ancient and universal

standard of length. Besides this we have the digit, thumb, palm, hand—breadth, span, foot, pace and fathom, and also the yard, from the Saxon "gyrdan," or girth. All of these measures came into use independently and at different times and places. They consequently varied greatly among themselves, though there was a generally recognized proportion between them, as is shown in the following table:

	Parts.
Digit; breadth of middle part of the first joint of the forefinger	1
Palm, or hand-breadth	4
Span	12
Foot	16
Cubit	24
Step, or single pace	40
Double pace	80
Fathom; between tips of fingers with arms extended	96

Most ancient measures have been derived either from the cubit, of 20.63 British inches, or from the digit of .729 in. The cubit of 20.62 ins. was the standard used in building the Pyramids, and several cubit rods have come down to us that were made about 1,000 B. C. When taken together, these average 20.65 ins. in length. This same standard is also found in Babylonia, Assyria and in Asia Minor, and ten ancient buildings in these localities, taken together, give a mean of 20.63 ins. The cubit was usually divided into fifths; the foot of three-fifths being as important as the cubit. The Greek derivation from this cubit was a foot of 12.45 ins., as derived from the average of 13 Greek structures. This foot may possibly have reached Roman Britain, and seems to appear in the English medieval building foot of 12.47 ins.

The digit of .729 in. is found as a standard, distinct from the cubit, in Egypt, Asia Minor, Syria, Persia and Assyria, particularly at Nimrod. From this digit was derived a cubit of 18.23 ins., or 25 times the digit of .729 in.; which had no relation with a cubit of 20.63 ins. This shorter cubit seems to have been the one in use among the Hebrews in the time of the kings, and also was the Olympic cubit. The Greeks constructed a foot of two-thirds of this short cubit; but used it in land measure only. The Italian or Roman foot of 11.62 ins. (16 × 726) is evidently derived from this same system, though possibly indirectly through the Greeks.

There are several other ancient standards which cannot be connected with the above. These are the 25.1-in. cubit of the Talmudic temple measure and for royal Assyrian and Persian use; the 21.6-in. cubit used by the Hebrews after the captivity, and in Assyria and Asia Minor; and the 22.2-in. cubit of Carthage. The half of the 21.6-in. cubit, or 10.8-in. was the Assyrian and the South Italian, or Oscan foot; and the 13.3-in. foot, found in Asia Minor, seems to have passed to northerly Greece and then to reappear as the Belgic foot of the Tungri, which passed over to England and was the most common building foot up to the fifteenth century; it averaged 13.22 ins.

The foot of Europe seems to have thus been derived from Greece, and tradition says it was regulated by the foot of Hercules. But in its transmission from one point to another, and by change of units, its length varied from the 9¾ in. Pythic standard to the 19 in. Genevan foot, both reckoned in modern English inches. Even as late as 1832 there were in Italy 215 foot measures of different length; and in Germany there were certainly not less in the beginning of this century.

The yard as a standard of length comes from the Saxon "geard, gyrd, gyrdan," meaning girth, the circumference of the body. It was brought into England by the Saxons, who found there the Belgic foot of 13.22 ins. The old British standards were as follows, the inches being those now in use:

3 feet = 1 yard = 39.66 ins.
2 yards = 1 fathom = 79.32 ins.
10 fathoms = 1 chain = 793.2 ins. = 66 ft.
10 chains = 1 furlong = 660 ft.
10 furlongs = 1 mile = 6,600 ft.

It will be observed that we have a survival of the old English system in the Gunter's chain and in the furlong. Tradition says that the yard lost its character of girth-soon after the Norman Conquest, and was then readjusted as a standard by the arm of Henry I.

Prior to 950 A. D. the Saxon standards were kept at Winchester under a decree of Edgar I., and there copies were compared and stamped; but later the Normans removed the standards to Westminster. An old statute of Henry III. (1224) lays down the rule:

3 barley-corns = 1 inch.
12 inches = 1 foot.
3 feet = 1 ell, or ulna.
5½ ulnes = 1 perch.
40 perches in length and 4 ins. in breadth = 1 acre.

The barley corns were to be "faire and round, taken from the middest of the ear," and were to be dry and laid end to end. The oldest existing British standards of length are a yard-bar of Henry VII., dated 1490, and one of Elizabeth of 1588. These differ by little more than 1-100 of an inch from the present Imperial British yard.

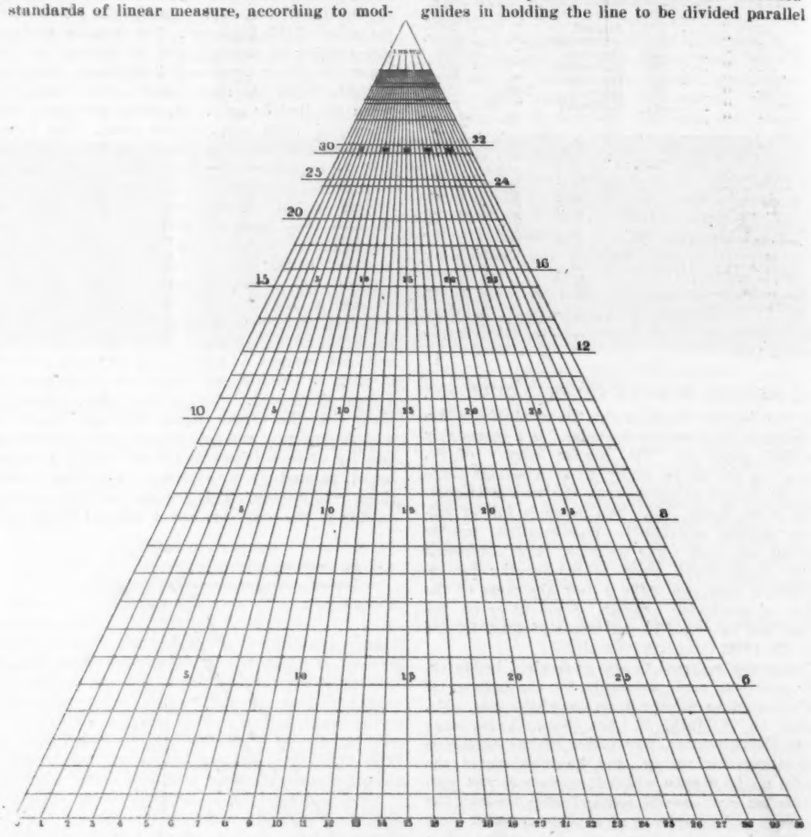
The first accurate comparison and measurements of standards of linear measure, according to modern scientific methods, was made in England in 1797 by Sir George Shuckburgh Evelyn. He used a comparateur made by Troughton, of London, with microscopes and cross-wires and a micrometer screw, by means of which .0001 of an inch could be measured; the temperature was also constantly observed. The results obtained by this investigator were as follows:

		Inches.
Yard of Henry VII.	A. D. 1490	35.924
" " Elizabeth	1588	36.015
" " Guildhall	1600	36.032
" " Clockmaker's Co.	1671	35.972
Rowley's Tower Standard	1720	36.004
Graham's scale, by Sisson	1742	36.0013
Same in the Exchequer		35.9933
Gen. Roy's scale, by Bird	1745-60	36.00036
Mr. Aubert's scale, " "	"	35.99880
Royal Society's scale, "	"	35.99955
Bird's Parliamentary Standard	1758	36.00002
Bird's Parliamentary Standard	1760	36.00002

The standards made by Bird in 1758 and 1760 were adopted as the legal British standard by an act passed June 17, 1824, after another series of comparisons extending from 1816 to 1824. The act went into effect on Jan. 1, 1826. This standard was destroyed in Oct. 16, 1834, by the burning of the Houses of Parliament. The bar was recovered, but in a damaged condition, with one of the gold plugs melted out. A committee of scientific men was appointed in 1838 to consider the restoration of the standard; they reported in Dec. 1841, and in 1843 a commission was appointed to restore the lost standards. In their report they pointed out the fact that there were errors in the methods originally used, and after much discussion and experiment with metals, a new standard yard was produced and legalized by an act passed June 30, 1855, and still in force.

THE UNIVERSAL SCALE.

The universal scale here shown is intended to facilitate the operation of dividing a line of unknown length into any number of equal parts, or for dividing a line of known or unknown length proportionately to another line of known or unknown length. The scale consists of a triangle with a base and altitude of 6 ins. The base is divided into 30 parts, and these parts are connected with the apex of the triangle by radial lines. The lines drawn parallel to the base are intended as guides in holding the line to be divided parallel to the base line. The lines marked 5, 6, 8, etc., are lines of scales on which there are 5, 6, 8, etc., parts to an inch respectively.



THE UNIVERSAL SCALE.

To divide a line of unknown length into any number of equal parts: Mark on the edge of a strip of paper the length of the line as taken from the drawing. Let us suppose it to be divided into 12 parts. Fit it between the 0 and 12 radial lines on the scale by sliding it up and down till it fits, keeping the edge of the paper parallel to the base of the triangle. Mark the 12 parts, and then apply it to the drawing, using it as a scale. To divide a line of known or unknown length proportionally to another of known or unknown length proceed as follows: To divide a line into the proportion of 5 to 6, take the length of the line on a strip of paper, and apply it to the scale between 0 and 11 radial lines; mark the point where the 5 radial line cuts the strip. The line will then be divided into the required proportion. When a line to be divided is longer than the base of the triangle, bisect it once or twice, as necessary, and treat it by parts. If the number of the parts into which the number is to be divided is an odd number, as 7, make it an even one by dividing it by 2 or 4 when the line to be divided is longer than the base of the triangle; and then mark every second or fourth part.

This universal scale is engine divided and printed on Bristol board; it may be obtained for 25 cts. from Mr. J. E. G. Yalden, 144 West Ninety-fourth St., New York city.

TESTS OF PAVING BRICK.

The city of Easton, Pa., is about to lay some brick paving, and, by request of the council, tests of the brick submitted were made by the testing laboratory of the Department of Civil Engineering at Lafayette College, Easton. The results are given in the accompanying table, for which we are indebted to Mr. H. R. Fehr, City Engineer. The contract was awarded to the United States Fire Clay Co. The samples of brick were as follows: A, John Porter Co., New Cumberland, Md., repressed brick, beveled edges; B, McMahon, Porter & Co., New Cumberland, Md., repressed brick, square edges; C, Buckeye Brick Works, Wellsville, O., repressed brick, beveled edges; D. United States Fire Clay Co., Pittsburg, Pa., ordinary brick, square edges. Three specimens of each kind were tested, making twelve specimens tested.

The abrasion and absorption tests were made on half bricks. Time in rattler, 2 hours; the rattler being 20 ins. diameter and 24 ins. long, making 40 revolutions per minute. Time, in oven, 2 hours; temperature of oven, 100° C. (212° F.). Time in distilled water, 24 hours; temperature of water, 68.5° C. (155° F.). Other tests of paving brick have been published in our issues of June 21 and 28, 1890; April 11 and Sept. 26, 1891.

Mark.	W'ght of brick in lbs.		Density. Wt. lbs. per cu. in.		Abrasion. Loss per cent.		Absorption. Gain. per cent.	
	E'ch.	Av.	Each.	Av.	Each.	Av.	E'ch.	Av.
A_1	6.55	....	0.0745	.....	20.62	.....	4.5	....
A_2	6.78	....	0.0758	.....	17.55	.....	3.9	....
A_3	6.51	6.61	0.0802	0.0788	14.72	17.63	3.2	3.86
B_1	6.57	....	0.0761	.....	29.56	.....	3.9	....
B_2	6.81	....	0.0739	.....	21.01	.....	3.7	....
B_3	6.83	6.74	0.0740	0.0736	21.53	25.04	4.7	4.10
C_1	6.98	....	0.0794	.....	34.10	.....	4.1	....
C_2	6.97	....	0.0780	.....	34.42	.....	4.2	....
C_3	6.91	6.95	0.0765	0.0779	24.82	31.11	4.2	4.16
D_1	7.27	....	0.0745	.....	19.55	.....	5.4	...
D_2	6.99	....	0.0759	.....	15.02	.....	3.3	....
D_3	6.98	7.08	0.0728	0.0744	15.93	17.03	3.7	4.13

COST OF SEWERS AT CORDELE, GA.

The following unusually detailed summary of the cost of 2.6 miles of 8 to 18-in. sewers put in at Cordele, Ga., in 1891, was sent us by Mr. Geo. G. Earl, C. E., who was engineer for the work:

The 18, 12 and 10-in. pipe was all included in the outlet sewer, in connection with which there was 300 ft. of 22-ft. cutting, over half the line being in thoroughly saturated ground. There were 35 manholes connected with the sewers. Labor cost from 80 cts. to $1 per day, and the foreman was paid $70 per month.

The accompanying table, rearranged in order of size of pipe and average depth of cut, was sent by Mr. Earl, and gives the cost of the work in detail:

Cost of Sewers at Cordele, Ga.

Size, ins.	Av. cut, ft.	Length, ft.	Labor. Total, $.	Labor. Per ft., cts.	Foreman. Total, $.	Foreman. Per ft., cts.	Labor and foreman, per ft., cts.	Pipe, per ft., cts.	Hauling sand and cement, per ft., cts.	Total cost, labor and material, per ft., cts.	5% for incidentals, per ft., cts.	Total cost, per ft., cts.
8	5.9	1,185	167	14.1	12	1.0	15.1	11.0	2	28.1	1.4	29.5
8	6.0	287	57	19.9	..	...	19.9	11.0	2	32.9	1.6	34.5a
8	6.1	977	195	19.9	..	...	19.9	11.0	2	32.9	1.7	34.6b
8	6.7	599	110	18.3	11	1.9	20.2	11.0	2	33.2	1.6	34.8a
8	6.8	473	81	17.1	6	1.2	18.3	11.0	2	31.3	1.6	32.9
8	7.0	3,090	704	22.8	60	1.9	24.7	11.0	2	37.7	1.9	39.6
8	7.9	240	100	41.6	9	3.9	45.5	11.0	2	58.5	2.9	61.4c
8	7.5	391	77	19.7	11	2.9	22.6	10.5	2	35.1	1.7	36.8
8	7.6	794	259	32.6	14	1.8	34.4	11.0	2	47.4	2.4	49.8b
8	7.7	488	106	21.8	14	2.9	24.7	10.5	2	37.2	1.7	38.9
8	8.0	900	304	33.8	17	1.9	35.7	11.0	2	48.7	2.4	51.1b
8	8.6	391	77	19.8	15	3.7	23.5	10.5	2	35.5	1.8	37.3
8	11.2	487	172	35.2	28	5.8	41.0	10.5	2	53.5	2.7	56.2
Tots. & avs.	7.1	10,301	2,409	23.4	197	1.9	25.3	10.8	2	48.1	2.4	50.5
10	7.0	225	60	26.7	..	...	26.7	16.5	3	46.2	2.3	48.5b
10	7.1	298	106	35.5	5	1.6	37.1	16.5	3	56.6	2.8	59.4b
12	5.4	1,044	282	27.0	12	1.1	28.1	22.0	4	54.1	2.7	56.8b
18	6.7	963	323	33.5	16	1.7	35.2	42.5	5	82.7	4.1	86.8b
18	10.6	867	687	79.2	35	4.0	84.6	42.5	5	130.7	6.5	137.2b
Totals.		13,699	3,867		265							

In addition to the $3,867, given above, for labor, there were expended $462 for mason and helpers and $17 for "odds," making a total of $4,345.

The various items entering into the total cost of the 2.6 miles of sewers and 35 manholes were as follows:

Labor	$4,345	Brick	252
Foreman	266	Cement	$106
Supervision	1,000	Hauling	82
Pipe	2,635	Manhole covers	280
		Tools and incidentals	561
		Total	$9,501

Mr. W. F. Crotts was assistant engineer in charge of construction, and Mr. W. W. Shipp was chairman of the sewerage committee.

ELEMENTS OF WEATHER IN THE UNITED STATES OF MOST INTEREST TO ENGINEERS FOR THE MONTH OF FEBRUARY, 1893.

[Furnished to Engineering News by the Department of Agriculture.]

	Station.	Temperature. (Deg. Fahr.) Average	Max.	Min.	Range.	Wind. Velocity miles per hour. Average	Max.	Direction at time of max. velocity.	Precipitation—rain and melted snow—inches. Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	13.7	48	−20	68	10.6	52	N	2.47	0.75	16
	Portland, Me.	20.2	53	−6	59	9.3	38	S	4.51	0.92	14
	New York, N. Y.	29.6	54	4	50	13.6	45	NW	7.81	1.93	13
	Pittsburg, Pa.	31.8	69	2	57	7.4	36	NW	4.74	0.76	19
	Chicago, Ill.	21.2	46	−9	55	20.8	60	SW	2.44	0.87	14
	Omaha, Neb.	19.5	52	−16	68	9.9	35	NW	0.97	0.34	9
	St. Paul, Minn.	9.1	37	−26	63	9.0	35	NW	1.87	1.12	10
	Duluth, Minn.	8.2	36	−23	64	6.7	35	NW	1.64	0.64	15
	Bismarck, N. Dak.	4.4	37	−41	78	10.8	47	NW	0.20	0.09	7
	Average	17.5	46.9	−15.6	62.4	10.9	42.6	.....	2.96	0.83	13
Southern Cities.	Washington, D. C.	35.1	65	11	54	8.7	42	NW	4.25	1.48	13
	Louisville, Ky.	36.2	60	3	57	10.4	48	W	4.58	1.02	14
	St. Louis, Mo.	30.8	58	−1	59	11.5	48	W	2.98	0.91	9
	Savannah, Ga.	56.8	81	34	47	9.6	50	SW	4.73	2.67	12
	Leavenworth, Kan.	26.6	58	−8	66	11.0	39	NW	1.69	1.02	7
	Jacksonville, Fla.	61.6	82	41	41	8.0	42	SE	6.87	2.00	10
	Chattanooga, Tenn.	46.2	70	22	48	7.3	30	SW	8.02	2.49	15
	New Orleans, La.	61.2	79	39	40	10.6	30	NE	4.92	2.72	10
	Memphis, Tenn.	43.6	71	16	55	9.6	34	E	6.33	3.81	13
	Palestine, Tex.	50.4	78	24	54	7.9	25	S	1.23	0.40	12
	Average	44.8	70.2	18.1	52.1	9.5	36.8	.....	4.56	1.75	12
Western Cities.	Helena, Mont.	12.2	43	−41	84	6.5	35	SW	0.58	0.21	8
	Port Angeles, Wash.	34.6	48	7	41	5.7	44	N	5.23	1.88	16
	San Francisco, Cal.	50.3	69	39	30	8.4	38	SW	2.75	1.06	9
	Salt Lake City, Utah	28.5	49	5	44	5.7	37	NW	1.64	0.27	17
	Denver, Colo.	31.4	60	−2	62	8.4	40	NW	0.83	0.44	8
	Yuma, Ariz.	60.1	87	32	55	8.0	39	W	T	T	0
	Santa Fé, N. Mex.	33.8	52	15	37	7.8	46	SW	0.76	0.24	11
	Average	35.8	58.3	7.9	50.3	7.2	39.9	.....	1.68	0.59	10

Mr. Crotts was assistant engineer in charge of construction, and Mr. W. W. Shipp was chairman of the sewerage committee.

Two important patent decisions have been rendered this week. In the United States Circuit Court of New Jersey, Judge Green, on March 28, handed down a decision sustaining the Edison "feeder" patent, covering the use of independent feeders to maintain the voltage substantially uniform on all parts of an extended system of conductors.

A United States Supreme Court decision on March 28 laid down the rule that a United States patent granted after a foreign patent for the same invention has issued and become void cannot be sustained. In the case in question the inventor obtained a patent in Great Britain in 1874, and it became void in 1881, through the non-payment of the $500 fee which was required at the expiration of seven years from the date of the patent. The United States patent was issued in 1882, and is now declared void under the clause of the patent law, which limits the duration of the United States patent to that of the earliest foreign patent covering the same invention.

The Alaska-British Columbia boundary survey is to be continued, and three parties will be sent out by Superintendent Mendenhall on April 10. The Canadian government will also have parties in the field. Parts of this boundary line were run in 1889-90, at the 141st meridian, on the Yukon and Porcupine rivers, and from Yakutat Bay in 1892.

Work on the Hudson River Tunnel is probably to be recommenced, according to a London news item. After 15 months of suspended work, the first mortgage bondholders have decided to raise $1,000,000, which it is estimated will complete the 1,500 ft. of actual tunnel yet to be driven. Negotiations are now said to be in progress for raising this money.

The damming of the Delaware River for power purposes, between Trenton and Easton, is being agitated by the Trenton Board of Trade. The state of New Jersey granted the right to dam half the river 20 years ago, and legislative power is now to be asked from the Pennsylvania Legislature. The claim is made that a dam a few feet high above the Trenton Falls would furnish Trenton 20,000 HP. for electric lighting and other purposes.

A new solder for aluminum is given by the London "Engineer" as follows: Cadmium, 50 parts; zinc, 20 parts; tin, 30 parts. The zinc is first melted in a crucible and the cadmium then added, and lastly the tin.

A universal telegraphic hour is asked for by the "Journal Telegraphique," of Paris. The proposition is practically the standard time system long advocated for general use, counting the hours from one to twenty-four from some fixed meridian. The idea is a good one, in telegraphic communication especially, as the electric fluid in passing from Australia to America, for example, can beat the sun by almost a whole day.

The Sanitary League of the District of Columbia was recently organized to work in conjunction with the Commissioners of the District in securing information regarding nuisances and abating them. Dr. J. S. Billings addressed a citizens' meeting a few days ago to set forth the proposed work of the league. At this meeting views were shown of some parts of the city requiring sanitary renovation. Dr. Billings stated that the league is entirely new for cities in the United States as large as Washington, although it had been tried in some villages in this country, and also in foreign cities.

The Pennsylvania R. R. expended last year on its Southwest system $483,054 for engines; $300,542 for passenger cars, and $666,343 for freight cars, making the total cost $1,550,939.

The Hemet Dam, near San Jacinto, Cal., is said to have been completed to a height of 110 ft. and to be already filled with water to the height of 90 ft.

Swedish mechanical engineers are to be aided to visit the World's Columbian Exposition by a special appropriation of 50,000 crowns (about $16,600), made by the Swedish government. The rulers of that country

are shrewd enough to realize that the prosperity of a country's manufacturing industries depends in no small degree upon the abilities and the information of its mechanical engineers.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Drainage of Surface Water Into Highway.

The owner of land adjoining a highway has no right to drain his land into a ditch in such highway by means of a drain which carries the water in a different direction from its natural flow. The statute which forbids the obstruction of highways by ditches, and authorizes the highway commissioners to fill up such ditches, "except the ditches necessary to the drainage of an adjoining farm emptying into a ditch upon the highway," allows them to fill up a drain which empties into a ditch on the highway where such drain, in order to reach the ditch, diverts the water from its natural course.—(Davis v. Comm. of Highways, Supr. Ct. Ill., 33 N. E. Rep., 58.)

Damage to Street Railway by Construction of Sewer.

The location of a sewer in a city street must be reasonable, with respect to the right of a street railway the construction of which was authorized by a prior ordinance and whose property might be damaged by the construction of such sewer; and such location, if made in a part of the street occupied by the railway, so as to compel it to suspend operations, and inflict great damage upon it, is unreasonable when other parts of the street are equally suitable for the sewer. But the city is not required to incur any additional expense by reason of having authorized the building of such road. (Clapp v. City of Spokane, U. S. Circ. Ct., D. Washington, 53 Fed. Rep., 515.)

Liability of City for Damages from Street Improvements.

A city, in opening a street, took property on which was located one-half of a double brick house, the other half of which was owned by one other person; and the latter half of the building was greatly damaged. As it was thought no compensation could be allowed the owner, because none of his property was actually taken, the city council requested the legislature to pass an act, authorizing it to make compensation, which was done. While the bill was pending in the legislature, the owner of the property made a contract with the city by which it sold him the portion of the building taken, and he released it from all claims for damages; proceedings by the owner, under the act, to compel the city to make compensation, should not be stayed because of such contract, it appearing by the affidavits filed on his behalf, that he signed the contract on the assurance of the corporation counsel that he could procure a small strip of land, left between his half of the building and the street, so as to restore his building to a proper condition, and that he was unable to do so; and that the expense of taking down and removing the property sold him by the city was equal to its value; but, if there was any excess of such value over the expense, he should be compelled to allow it in reduction of damages. (In re Elmwood Ave., 21 N. Y. Sup., 592. Supr. Ct. of Buffalo.)

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

OHIO SOUTHERN.—Grading has been begun on the Lima end of the extension from Springfield to Lima, O. Work from Springfield north has been in progress for some time.

BANGOR & AROOSTOOK.—Subcontracts are being let for the section between Brownsville and Sherman, Me. C. P. Treat, Gen. Contr., Houlton, Me.

BALTIMORE & DRUM POINT.—The Baltimore "Herald" states that this project to build a railway to Drum Point, Md., 52 miles, is being revived. The line was partly graded some years ago.

BOSTON & MAINE.—There is talk of double tracking the Eastern Division from Boston to Newburyport, Mass. The work, if carried out, will necessitate the widening of the Salem Tunnel.

INGALLS & WHITE RAPIDS LOGGING.—A syndicate has been formed to build a connecting railway line between Iron Mountain and Menominee, Mich., using the Ingalls & White Rapids Logging Ry., which would leave 15 miles to build from Iron Mountain to the north end of this road, and 19 miles from Menominee to the south end. A tract of land has been secured in Menominee of 1,500 ft. for ore docks and 80 acres have been secured adjoining for other purposes.

BALTIMORE & OHIO.—It is stated that the section of the Pittsburg Division between Connellsville and Sand Patch, Pa., will be improved by constructing 32 miles of side track, which can be eventually changed to form a second track.—A press dispatch says: "Vice-President King of the Baltimore & Ohio is authority for the statement that during the coming summer the Baltimore & Ohio will tunnel Whitehall Hill, and also Thomas Hill, on the Pittsburg Division. The Whitehall tunnel will be over 3,000 ft. in length, and the improvements will shorten the distance between Pittsburg and Washington more than five miles, bringing the two cities within an easy hour's ride of each other. When completed, the use of double-headers for freight trains going over these steep grades will be done away with."

Projects and Surveys.

MANISTIQUE & NEGAUNEE.—Ch. Engr. S. H. Beardslee, Manistique, Mich., writes that the surveys have been completed for this railway from Manistique to Negaunee, Mich., 90 miles, and that if everything is favorable the line will be put under construction this year.

NEW YORK CANADIAN PACIFIC.—This company has issued a prospectus explaining the advantages of a new route from Prescott, Ont., to New York, N. Y. The company was formerly known as the New York, Ottawa & Northwestern Ry. Co., and has been in existence for some years. A story has been published stating that the Canadian Pacific Ry. was backing the scheme with a view of getting an independent entrance into New York, but the officials of that company deny the statement, and there seems little probability in it.

LANDISVILLE & CAPE MAY.—A press dispatch says: "Surveyors on the proposed new railroad to connect Cape May with Landisville, on the Reading system, will work from both ends of the line on and after April 3. When they complete their preliminary survey a charter will be taken out by the new company. Since the weather moderated they have been working through South Jersey, seeking the shortest route to the sea. The road will follow the bay shores and will, when completed, furnish a convenient outlet for its bay industries of fishing, oystering and clamming. The promoters of the road say it will be running during the coming summer. Some prominent Philadelphia subscribers to the capital stock are John C. Bullitt, Thomas Robb, Theo. M. Eting, Saml. Gusline Thompson and D. Ramsay Patterson."

INDIANAPOLIS, BLOOMINGTON & BEDFORD.—This company, whose incorporation was noted in our last issue, has completed the surveys for its line from Indianapolis to Bedford, Ind., 80 miles. The line passes through the oolitic stone-fields. Gen. Man., Benj. Thompson, M. Am. Soc. C. E., Bloomington, Ind.

GRAND RIVER & MAHONING.—This company, whose principal office is in Cleveland, has just been organized, with a capital stock of $1,000,000, to construct a road from the south shore of Lake Erie at Grand River to Steubenville. The incorporators are James Ritchie, Thomas Deering, E. J. Blendin, E. Tupper and William L. Rice.

OHIO RIVER, SMITHFIELD & LAKE ERIE.—Chartered in Ohio to build a railway from Steubenville to Cleveland, O. Incorporators: Hugh Hammond, Evan H. Purvance, Wm. Hammond, Geo. W. Doty and Lewis McLeaver. Principal offices, Steubenville, O.

NORWALK, FAIRFIELD & SOUTHERN.—Organized in Ohio to build a railway to be operated by steam or electricity, between Norwalk and North Fairfield, O. Incorporators: Chas. P. Wickham, T. F. Hildreth, Jay F. Fanning, Harry H. Hoyt, and others.

PHILADELPHIA, HONESDALE & ALBANY.—Chartered to build a railway from White Haven, Luzerne Co., Pa., to the New York state line, near Equinunk. Capital stock, $2,700,000. Pres., Henry J. Russell, White Haven, Pa.

Southern.—Existing Roads.

LOUISVILLE & NASHVILLE.—An exchange says that the construction of an extension from Jellico to Harriman, Tenn., is a probability.

WEST VIRGINIA CENTRAL & PITTSBURG.—It is stated that plans are about completed for building the extension from Cumberland to Hagerstown, Md.

NASHVILLE, JELLICO & CHARLESTON.—It is reported that this railway will be extended from Jellico, Tenn., to Murphy, N. C., and from Athens to Kingston, Tenn. Supt., J. C. Anderson, Athens, Tenn.

Projects and Surveys.

ABBEVILLE SOUTHERN.—It is stated that this company is about ready to let the contract for the construction of its line from Abbeville to Dotham, Ala., 28 miles.

NASHVILLE, MORRISTOWN & ATLANTIC.—This company has offered to build the Unaka & Nola Chucky Ry. from Morristown to Embreeville, Tenn., if the company can secure aid to the amount of $200,000 per mile and free right of way. J. L. Cain, of Morristown, Vice-Pres. of the Unaka & Nola Chucky, is reported as saying that 80% of the right of way is already secured, and that the rest will soon be obtained. He also says that it is necessary to secure only $65,000 of additional stock to enable the company to close the contract. The line will be about 60 miles long, and surveys will soon be commenced. The Nashville, Morristown & Atlantic is projected from Nashville to Bristol, Tenn., and the Unaka & Nola Chucky is to become a part of the system.

LETOHATCHIE & HAYNEVILLE.—Steps are being taken to build a railway from Letohatchie to Hayneville, Ala.

MANCHESTER & AUGUSTA.—This company will, it is stated, soon commence building its line from Sumter to Denmark, S. C.

DUNNELLON PHOSPHATE R. R. & TRANSPORTATION CO.—Incorporated in Florida to build a railway from Dunnellon to Amelia Island, and Dunnellon south to Tampa Bay. Incorporators, C. K. Dutton, New York, N. Y.; W. L. Bradley, Boston, Mass.; Joseph Shumacher, and J. R. Tysen, Jacksonville, Fla.

Northwest.—Existing Roads.

GREAT NORTHERN.—The contract for building the 20-mile extension of the Park Rapids Branch has been let to Foley Bros. & Guthrie, St. Paul, Minn.

Southwest.—Existing Roads.

TEXAS & SABINE VALLEY.—Work is reported commenced on this 30-mile line from Carthage to Center, Tex., and two miles of track laid. Ch. Engr., Rich. J. Evans, Longview, Tex.

GALVESTON, HOUSTON & HENDERSON.—It is stated that a branch four miles long is to be built.

CHICAGO, ROCK ISLAND & PACIFIC.—The contract for grading 50 miles of the extension from Bowie to Ft. Worth, Tex., has been let. Engr., R. W. Day, Topeka, Kan.

TEXAS CENTRAL.—Surveys are being made for a branch to the Thurber coalfields in Texas, 35 miles. There is some prospect of the line being built this year.

ST. LOUIS, KEOKUK & NORTHWESTERN.—The line from Cuivre Junc. to St. Louis, Mo., has been completed with the exception of the bridge over the Missouri River.

TEXAS & GULF.—The donation of $40,000 required to be raised by Marshall, Tex., to secure the building of this road has been secured. The contract requires the company to build a standard gage road to Center, 60 miles south of Marshall. It is believed that active work will begin in 30 days. Thirteen miles of this road has been graded for several years.

KANSAS CITY, OSCEOLA & SOUTHERN.—Gen. Man. R. S. Josselyn has under consideration a plan to extend his road south from Osceola, Mo., through Southwest Missouri, and through Arkansas to Clarendon, Ark., there to connect with the Cotton Belt for Memphis, and the Arkansas Midland for Helena and New Orleans.

MISSOURI, KANSAS & EASTERN.—This company has completed its line from Portage des Sioux to New Franklin, Mo., 162 miles; 57 miles of track having been laid since Jan. 1, 1893.

Projects and Surveys.

WACO & NEW ORLEANS.—A press dispatch says: "The committee of the Waco and New Orleans railway project met here, and Henry C. Rouse, President of the Missouri, Kansas & Texas Ry., having made the statement that his company was not prepared at present to take up the offer of building a line eastward from Waco, offers from the Texas Central were considered. The committee adopted the line from Waco to Cheneyville, La., through the Texas counties of Limestone, Leon, Houston, Angelina, San Augustine, Sabine and Newton, and the Louisiana parishes of Vernon and Rapides. The county determined to recommend the building of the line by the cities independent of all railways operated, but will correspond with the Texas Central Ry., and if that company gives the support which will be demanded the Waco & New Orleans Railway will become an extension of the Texas Central."

MYRTLE SPRINGS SHORT LINE.—This company has been incorporated by E. A. Shaver and E. T. Castle, of Pittsfield, Mass.; G. C. Rowley, of Blandford, Mass.; W. A. T. Murray, Jno. T. Reynolds and others. The company intends building a railroad from Myrtle Springs to some point on the Texas Pacific. The capital stock is $80,000.

LAKE PROVIDENCE & BAYOU MACON.—There is talk of a narrow gage railway between Lake Providence and Bayou Macon, La.

TEXAS.—A company has been formed to build a railway from Sierra Blanca, Tex., to a connection with the Galveston, Harrisburg & San Antonio R. R. Pres., Edw. Bissell, Sierra Blanca.——The Llano Improvement & Furnace Co. has accepted a proposition providing for the construction of a railway from Llano to Iron Mt., Tex.

GULF, BEAUMONT & KANSAS CITY.—This company has been chartered in Texas to build a railway through the counties of Jefferson, Hardin, Orange and Jasper, the ultimate Northern terminus being Kansas City, Mo. The Directors are H. J. Pratt and N. D. Silsbee, of Boston; John H. Kirby, of Houston; Wm. Weiss, W. A. Fletcher and W. C. Averill, of Beaumont. The officers are: H. G. Pratt, Pres.; John H. Kirby, Vice-Pres.; N. D. Silsbee, Treas.; W. C. Averill, Secy.

Rocky Mountain and Pacific.—Existing Roads.

NORTHERN PACIFIC.—Dispatches from Vancouver state that construction has begun on the Burrard Inlet & Fraser Valley R. R. from Sumas, Wash., to Vancouver, B. C.

SANTA FE, PRESCOTT & PHOENIX.—The grading is nearly completed on the 60-mile section from Ash Fork to Prescott, Ariz., and 35 miles of track have been laid. Ch. Engr., G. W. Vaughn.

Projects and Surveys.

MONTEREY & FRESNO.—Gen. Man. H. A. Green, Monterey, Cal., writes that the preliminary survey has been completed for this line from Monterey, Cal., to Salinas, San Juan, Hollister and Fresno, Cal., 162½ miles, and that the right of way is nearly all secured. The work will not be unusually difficult; maximum grade 80 ft. per mile, curves easy. There will be one large bridge and a 1,500-ft. wharf. The road must be completed by July, 1895. Pres., A. W. Jones, Kansas City, Mo. Ch. Engr., F. P. McCray, San Francisco, Cal.

Foreign.

BOGOTA & MAGDELENA.—A Denver Colo., paper gives the following additional details in regard to this company noted last week: "The Bogota & Magdelena Ry. Co. has filed articles of incorporation with the Secretary of State for the purpose of purchasing and operating the Girardot Ry., in the department of Cundinamarca, republic of Colombia, South America, by concession from the government to John H. Pennington. The incorporators are Geo. Sheppard, Morris W. Mead and Samuel E. Moore. The capital stock of the Bogota & Magdalena is $6,000,000, but there are two other companies—the Colombia Construction Co., and Fuquene Improvement Co.—which were also incorporated at the same time, and are the enterprises of practically the same gentlemen. They have separate organizations, however, and are stocked at $1,000,000 and $200,000, respectively. The stockholders are many, principally capitalists of Pittsburg, Indianapolis, New York and Bogota, the capital of Colombia. The directors are J. H. Pennington, James J. De Long, Morris N. Mead, S. E. Moore, George Sheppard, Alejandro Borda, Francisco J. Otera, J. J. Baldwin and E. F. Austin. It is proposed to build three lines of railway, about 500 miles in all, from Bogota to different points on the Magdalena River, the principal stream, running north into the Gulf. The construction company is to do the work under control of the first-named corporation. The improvement company has in view the draining of Lake Fuquene, which will redeem 500,000 acres of fertile agricultural land. The principal office of the company will be in Pittsburg, Pa., but the company has also a branch office in Denver, Colo., with Parsons & Yeaman as attorneys.

ELECTRIC RAILWAYS.

NEEDHAM, MASS.—The selectmen have granted a franchise to the Needham & Newton Electric St. Ry. Co., to build about 4½ miles of line.

BROOKLYN, N. Y.—The State Railroad Commission has granted the application of the Atlantic Avenue R. R. Co. of Brooklyn for a change of motive power to the overhead electric trolley system upon certain portions of its route not heretofore granted.

GRAVESEND, N. Y.—The Coney Island & Gravesend Ry. Co., capital $350,000, has been incorporated. The company will operate a street surface railway for a distance of 34 miles over the streets of Coney Island and Gravesend. The directors are: George W. Roderick, Sheepshead Bay; S. S. Williamson, H. R. Williams, Gravesend; Michael J. Daly, Ernest H. Davis, John Curren, Brooklyn; C. Stubenbord, Fred E. Bader, F. G. Gallagher, Coney Island.

NEW JERSEY.—The New England St. Ry. Co., recently organized to acquire the various street railroads in New England, has filed, in the office of the secretary of state at Trenton, N. J., a certificate increasing its capital stock to $2,025,000. The authorized capital of the company is $5,000,000. The directors, most of

whom are New England capitalists, are Albert C. Pond, John R. Bullard, James C. Ems, John H. Cunningham, W. B. Ferguson, W. H. Learnerd, Dr. A. F. Mason, A. R. Mitchell, T. F. Robinson and James B. Dill.

HOBOKEN, N. J.—The Hudson & Bergen Traction Co. has filed articles of incorporation. The capital stock is $5,000,000, in $100 shares, and $25,000 is paid in. The incorporators named are Myles Tierney, of New York; Theophilus Butts, of Hoboken, and Albert C. Wall, of East Orange. The purpose of the company is to absorb the North Hudson Ry. Co., running to Union Hall and other north Hudson towns, and also to Jersey City; and to build 36 extensions through other streets than those now traversed.

JERSEY CITY, N. J.—The United Traction Co. has been chartered in New Jersey to build and operate street railways in New Jersey and other states; capital stock, $8,000,000; Incorporators, Henry W. Calhoun, New York city; Adrian H. Larkin, Nutley, N. J.; Thorwald Stahlnecht, Orange, N. J.

PASSAIC, N. J.—The Passaic, Bloomfield, Montclair & Caldwell Electric Ry. Co. has been chartered to build and operate an electric railway. Capital stock, $2,000,000. G. B. Waterhouse and J. Kennell.

PHILADELPHIA, PA.—The select council in a special meeting has passed all the trolley ordinances of the non-traction lines. The ordinances grant trolley privileges to the People's, Green and Coates Sts., Germantown, Northern, Second and Third Sts. and the Cumberland and Huntingdon Branch, Frankford and Southwark, Citizens', Lehigh Ave., Chelton Ave., Centennial and Moyamensing and Penrose Ferry and the Hestonville, Mantua & Fairmount Passenger Ry. Co.

NORWALK, O.—The Norwalk & North Fairfield Electric R. R. Co. has been chartered by Hon. John A. Williamson, Harry H. Hoyt, Hon. C. P. Wickham, Rev. Dr. T. F. Hildreth, J. F. Laning, Hon. S. E. Crawford and Frank H. Evans, all of Norwalk. The road will eventually connect this place with the Big Four road to Mansfield and other points.

NEW ALBANY, IND.—An ordinance granting to the New Albany St. Ry. Co. authority to substitute electricity for animal power on the entire system in this city, and also to make such arrangements relative to poles, wire, etc., as may be necessary for the efficiency of the service, has passed the city council. Work will begin on the improvement at once, and it is expected that electric cars will be running to Louisville within 90 days.

KALAMAZOO, MICH.—The General Electric Co. is endeavoring to secure the right of way from Kalamazoo to Gull Lake. If successful an electric road will be constructed.

GRIFFIN, GA.—The Griffin St. R. R. Co. contemplates changing its lines to electric power.

NEENAH, WIS.—There is talk of building an electric railway from Neenah to Kaukauna, Wis., 12 miles.

HOUSTON, TEX.—J. M. Dorrance, C. H. Milby, T. J. Collins and others have applied to the city council for a franchise to build an electrical railway from Houston to Harrisburg.

OAKLAND, CAL.—A franchise has been granted to Oakland, Alameda & Piedmont R. R. Co., to build an electric railway.

HORSE AND MOTOR RAILWAYS.

HILLSBORO, ORE.—The Cornell & Barnes Heights Motor Line Co., is making surveys for its proposed line from Hillsboro to Portland, O.

ASHTABULA, O.—The city council has passed an ordinance granting a franchise for another street railway line between the city and harbor, to be run on the east side of the river. The road is to be completed June 1, 1894, and the franchise provides that for a period of five years from that date horses may be used, and thereafter electricity must be substituted.

ELEVATED RAILWAYS.

PHILADELPHIA, PA.—Pres. Charles W. Buscholtz, of the Quaker City and Northeastern Elevated railroad companies, is pushing the work on the lines, and wherever the company is not enjoined, it will proceed vigorously with the work of construction. Work on the Northeastern line is progressing at two points on the route above Market St. One of the sections is the three blocks between Market to Vine on Front St., and the other the three squares between Berks and Harrison sts. Upon the lower section the work has progressed favorably, and many of the foundations are ready for the iron structure.

BRIDGES, TUNNELS AND CANALS.

BERLIN, N. H.—The township has appropriated $16,000 to construct an iron brige across the Androscoggin River.

HAMILTON CO., N.Y.—A bill has been introduced in the legislature appropriating $40,000 for the construction of a bridge over Long Lake.

NEW YORK, N. Y.—The bill introduced into the New York Legislature by Mr. Marvin, providing for a $1,500,000 bridge over the Harlem Ship Canal has passed.

ROCHESTER, N. Y.—Bids will be received until April 5 for constructing the superstructure of a bridge over the Erie Canal. Ed. Hanan, Supt. Board Pub. Works, Albany, N. Y.

PITTSBURG, PA.—The Kensington Bridge Co. has been chartered in Pennsylvania. The directors are S. E. Moore, B. N. Rafferty, Jos. P. Cappsan, Howard Childs and Benj. Moore, of Pittsburg, Pa.

COLUMBUS, O.—An effort is being made to secure the construction of a railway viaduct over St. Clair Ave., to cost $65,000.

MINNEAPOLIS, MINN.—A bill has been introduced in the Minnesota legislature authorizing the city to issue $300,000 of bonds for building a wagon bridge across the Mississippi River, at the foot of Sixth Ave.

TUNNELS.—The Judson Tunnel Company has filed articles of incorporation in Colorado. The capital stock is $750,000. The incorporators are W. H. LaCosta, Fred LaCosta, L. C. Judson, Morgan Edgar and Richard Hampton.

HIGHWAYS.

MASSACHUSETTS.—The selectmen of Lincoln will receive bids until April 18 for building a new road in that township.

OHIO.—Martin Dodge, Cleveland, and D. S. Oliver, Cincinnati, are members of the recently appointed commission to look into the matter of country road improvements and the comparative cost of transporting produce to market by wagon and by electricity.

INDIANA.—The commissioners of Marion County have decided to advertise for bids for repaving the county roads, in compliance with the new law.

WASHINGTON.—The governor has approved Senate bill 190, providing for the establishment of a system of improved roads in counties, and providing for the manner of laying out, constructing and maintaining the same. This is known as the Lewis county road bill, and much is expected of it in improving the roads of the state. It is reported that the governor will also approve the bill providing for a state road through the Cascades by way of the pass north of Mt. Baker.

WATER-WORKS.

New England.

CHESTER, MASS.—A committee will report on building works.

WEST SPRINGFIELD, MASS.—The selectmen have been authorized, provided the people so vote, to issue $75,000 of 5% bonds for an additional water supply. The town has three years to accept or reject the act.

Middle.

ALBANY, N. Y.—Bids are wanted until April 4 for laying 5,600 ft. of 16-in and 14,000 ft. 8 to 16 in. mains. Geo. I. Bailey, Supt.

FAIRPORT, N. Y.—Chas. L. Peacock, C. C. Moore and five others have been elected water commissioners. Works are proposed.

GILBERTSVILLE, N. Y.—It is reported that plans for works are being made.

RICHMONDVILLE, N. Y.—Private works are projected.

TROY, N. Y.—Engrs. Elnathan Sweet and Wm. G. Raymond have reported on a new supply, suggesting two alternatives. The water commissioners, it is said, favor a partial development of the Quackenhill and Poestenkill at an estimated cost of about $500,000.

JERSEY CITY, N. J.—It is reported that bids are now wanted for a new supply, the bids to state the price for a minimum supply of 25,000,000 gallons, delivered to the Belleville reservoir, bidders to present their own general plans. A new cast-iron force main to the high service reservoir is proposed.

JEANETTE, PA.—It is reported that the citizens are talking of works with a supply from artesian wells. A Greensburg company now supplies water here.

MIFFLINBURG, PA.—The borough has voted $35,000 of bonds for works.

MOUNT CARMEL, PA.—It is reported that the company will build a 5,000,000-gallon reservoir.

NEW CASTLE, PA.—A company is proposed to supply West New Castle.

FREDERICK, MD.—An enlargement of the reservoir from 2,000,000 to 8,000,000 gallons has been recommended.

WASHINGTON, D. C.—Bids are wanted until April 11 for cast iron pipe and specials and valves.

Southern.

BERKELEY SPRINGS, W. VA.—It is reported that the Water & Improvement Co. will soon let contracts for works.

NEWNAN, GA.—A vote of 288 to 19 has been cast in favor of $50,000 of bonds for works.

CANTON, MISS.—The Canton Water-Works & Electric Light Co. has been incorporated; $50,000.

WALDO, LA.—Works are under consideration.

CLARKSVILLE, TENN.—The city talks of building works. A company now supplies water.

CLEVELAND, TENN.—B. S. Ridley, Murfreesboro, is said to be considering the building of private works.

North Central.

COLUMBUS, O.—The contract for cast iron pipe and specials has been awarded to the Ohio Pipe Co., at the following prices per ton: 4-in., $27.97; 6 to 12 in., $27.85; 16-in., $27.35; 20-in., $26.85; 24-in., $25.97; 30-in., $25.44; 36-in., $24.97; specials, $27.50.

HARTWELL, O.—The lowest bid for the new works was from Snyder & Williams, Dayton, $21,957.

NORWOOD, O.—The works will be built with G. Bouscaren as consulting engineer.

FOWLER, IND.—It is said that works will be built.

ALEXANDRIA, IND.—Works are under consideration, and, if built, will probably be owned by the city.

GREENFIELD, IND.—The council has accepted Irwin & Co.'s proposition to build works; estimated cost, $40,000, of which it is said that the city will pay $20,000.

BUCHANAN, MICH.—Bonds for works to the amount of $50,000 have been voted.

CICERO, ILL.—W. S. Shields, Consult. Engr., Chicago, has been engaged to prepare plans for new works, including about 48 miles of mains and a stand-pipe.

HIGHLAND PARK, ILL.—The plans prepared by Consult. Engr. W. S. Shields, of Chicago, have been accepted. Water will be drawn through a 16-in. intake pipe, extending 2,000 ft. into the lake, and pumped to a 16 × 100-ft. stand-pipe. Estimated cost of works, $50,000.

WEST PULLMAN, ILL.—Consult. Engrs. Alexander & Hill, Chicago, have been engaged to design and construct works. Water will be pumped from Lake Calumet to a 14 × 100-ft. stand-pipe.

OSWEGO, ILL.—Works are proposed.

KAUKAUNA, WIS.—All the bids for a franchise, noted last week, were rejected. New bids have been asked with the reservoir and filter omitted, a secondary pipe to the river added and depth of mains reduced from 6 to 5½ ft. April 1 was the date for receiving the new bids.

SOUTH MILWAUKEE, WIS.—It is reported that several Eastern parties are trying to secure a franchise.

Northwestern.

ROCK VALLEY, IA.—April 17 the people will vote on having works.

SIOUX CITY, IA.—A large number of meters may be put in.

OAKLEY, KAN.—It is reported that this place is to have works.

HASTINGS, NEB.—Two boilers will be added and a new engine house built.

DEADWOOD, S. DAK.—It is reported that the building of works is under discussion. A company now furnishes a supply.

Southwestern.

ST. LOUIS, MO.—Jas. Stewart & Co., Contrs., St. Louis, inform us that the contract for constructing settling basins Nos. 1 and 2 has been awarded to John Hill for $291,335. The other bids were: Jas. Stewart & Co., $310,025; Fruin-Bambrick, $318,575; Albert Veiths, $332,760; Heman Construction Co., $356,000; McCully Stone Mason Co., $367,040.

BRUSH, COLO.—Works are again proposed. Address Wm. Michell or C. B. Simpson.

DURANGO, COLO.—Bonds to the amount of $15,000 will be issued "to complete the system."

DEMING, N. M.—Surveys for the mains of the new works are in progress.

Pacific.

REDLANDS, CAL.—The Gladysta Water Co. has been incorporated to acquire water rights; $50,000.

ASTORIA, ORE.—A. L. Adams, of Adams & Gemmell, Pendleton, has made a preliminary survey for a new main from the Bear Creek reservoir to the city. It is probable that bids will soon be asked for 11¾ miles of iron, steel or wood pipe for the proposed line.

ARTESIAN WELLS.

MONTGOMERY, ALA.—Supt. Fred Crosby informs us that the Capital City Water Co. wishes bids for sinking a well.

IRRIGATION.

NEW COMPANIES.—Peralto Ditch Co., Johnson County, Wyo.; $17,000; J. C. Barr, Jack Dow; a canal will be taken out of Big Goose Creek. Timpas Valley Ditch Co., La Junta, Colo.; $30,000; A. E. Lewelling, J. P. Tryner. Franklin County Irrigating Co., Tacoma, Wash.; $1,250,000; A. C. Smith, D. K. Stevens. American Colony, Canal & Irrigation Co., Easton, Cal.; $28,800.

SEWERS.

BRUNSWICK, ME.—A village corporation has been formed to construct a system of sewers; clerk, Thos. H. Riley.

BOSTON, MASS.—The lowest bids for Sections 29 and 45 of the Metropolitan main sewer were those of Lindsey & Cudmore, $47,534 and $16,719, respectively.

FITCHBURG, MASS.—We are informed by David A. Hartwell, Cy. Engr., that the following sewers have been ordered, the work to be done by the city: 26 × 39 ins. and 18 × 27 ins. brick sewers, 5,180 lin. ft., to cost about $12,460; 10 to 18-in. pipe sewers, 15,620 lin. ft., to cost about $13,000. Other sewers will be ordered later in the season.

LEE, MASS.—The board of health desires an appropriation of $9,500 to commence the construction of a system of sewers.

NORTHAMPTON, MASS.—The city engineer is preparing plans for sewer work which will commence as soon as the frost is out of the ground.

PITTSFIELD, MASS.—The sewer commissioners will receive bids until April 8 for 250,000 hard-burned brick, 100 cast iron manhole covers and rims, 1,100 bbls. cement, and about 36,000 lin. ft. 6 to 18-in. vitrified pipe; also until April 15 for constructing about seven miles of pipe sewers. Ernest W. Bowditch, Engr.

WALTHAM, MASS.—The commissioners of sewers will receive bids until April 3 for a sewer to cost about $18,000; pipe, brick, etc., to be furnished by the contractor.

NEW BRITAIN, CONN.—A. W. Rice, Cy. Engr., informs us that no definite action will be taken as to proposed brick sewers until the new council meets about April 15. The work, however, will be done by the city by day work.

KINGSTON, N. Y.—It is reported that the citizens have voted $20,000 for a system of sewerage.

NEW BRIGHTON, N. Y.—The board of trustees will receive bids until April 3 for an extension of the Columbia St. sewer. J. F. O'Grady, Clk.

NEW YORK, N. Y.—The commissioner of public works will receive bids until April 5 for eight contracts.

ROCHESTER, N. Y.—The contract for a sewer in Hudson Ave. has been awarded to Thos. Oliver & Sons, at $14,261; estimate, $19,700.

TROY, N. Y.—Plans have been prepared for 12 to 20-in. sewers in North Troy.

BRIDGETON, N. J.—We are informed that the question of sewerage will soon come before the council.

CLAYTON, N. J.—An appropriation has been made for drainage purposes. S. C. Newkirk, Chn. Town Com.

JERSEY CITY, N. J.—The finance committee has approved the plans for the extension of the Ravine Road sewer to the Hudson River; total length, 6,700 ft., of which 5,600 ft. will be 48-in. iron pipe; estimated cost, $34,326. The work will be done by contract. Theo. Butts, M. T. Connolly and Edlow Harrison, commissioners.

PLAINFIELD, N. J.—The council has decided in favor of the intermittent filtration system of sewage disposal, and an election will be held to vote on the proposed issue of bonds for $100,000. The three systems proposed were referred to in our issue of March 16.

TRENTON, N. J.—The board of public works will receive bids until April 6 for several sewers.

PHILADELPHIA, PA.—Bids will soon be asked for sewers in 31 streets.

PITTSBURG, PA.—The contract for the Negley Run sewer has been awarded to Sloane & McIlvaine, at $145,218, the next lowest bid being that of W. J. Dunn, $190,563.

READING, PA.—The ordinance directing the construction of a sewage pumping plant and appurtenances, and to make an appropriation of $100,000 to pay for the same, has been concurred in by the councils.

BALTIMORE, MD.—The mayor has signed an ordinance appropriating $113,200 for a sewer in Fremont St.

SCRANTON, PA.—The contract for the Tenth district main sewer has been awarded to Dunn Bros., at $26,469; other bids being, Flanagan & O'Horn, $38,970; J. T. Fitzpatrick, $39,975; Howley Bros., $38,500.

BUCYRUS, O.—The city engineer will receive bids until April 4 for a sewer in Jones St.

FINDLAY, O.—Jarvis S. Humphrey, Cy. Engr., informs us that at present it does not seem probable

that the South Side sewer system will be constructed this year.

MARTIN'S FERRY, O.—Plans for a sewerage system have been prepared by Alexander Potter, Olean, N. Y., and are now being considered by the council.

NILES, O.—The council has instructed the clerk to advertise for bids for plans and estimates for a sewerage system.

ANN ARBOR, MICH.—The citizens have voted to issue bonds for $30,000, to build a main sewer.

IRON MOUNTAIN, MICH.—The city clerk will receive bids until April 17 for about 1½ miles of 8 to 15-in. pipe sewers.

INDIANAPOLIS, IND.—The board of public works has ordered 15 sewers, including a main sewer in Georgia St., length 4,784 ft., and a sewer in 14th St., length 11,155 ft., and will receive bids until April 3 for certain of them.

CHICAGO, ILL.—It is estimated that $3,000,000 will be collected by special assessment for sewer construction this year.

MUNCIE, IND.—The city clerk will receive bids until April 10 for an 8 to 18 in. pipe sewer.

HASTINGS, MINN.—The contract for the court house sewer has been awarded to Nehemiah Martin and A. E. Johnson, at $6,000.

WEST DULUTH, MINN.—Plans have been prepared for a system of sewers, both storm and sanitary. The village has 24.7 miles of improved streets.

FARGO, N. DAK.—Plans have been prepared for 4,154 lin. ft. of 18 to 24-in. pipe sewers, average cut 11 ft., and estimated to cost about $12,000. The work has not yet been advertised. J. T. Graves, Cy. Engr.

BURLINGTON, IA.—William Steyh, Cy. Engr., informs us that no sewers have yet been ordered, but will be soon.

NEVADA, MO.—The council has appointed a committee to prepare surveys and estimates for sewer extensions. E. K. Blanchard, Cy. Engr.

WESTPORT, MO.—The question of sewerage is to be voted upon at the election April 4.

DURANGO, COLO.—The citizens will soon vote on the issue of bonds for $50,000 for a sewerage system.

AUBURN, CAL.—J. B. Meredith has been appointed engineer to prepare plans for the proposed sewer system, referred to in our issue of March 16.

STREETS.

BOSTON, MASS.—The superintendent of streets will receive bids until April 5 for 300,000 paving brick.

NEW BRITAIN, CONN.—The proposition to issue bonds for $100,000 with which to macadamize all the streets is being discussed by the council.

BUFFALO, N. Y.—The department of public works will receive bids until April 5 for 19 contracts for paving with German rock asphalt, bituminous rock, dressed block Medina sandstone and brick.

NEW YORK, N. Y.—Contracts for repaving with granite blocks have been awarded as follows: James Pollock, at $76,548; James Baird, at $22,575; Thomas Clearty, at $61,962; J. G. Smith, at $57,265; Wm. Kelly, at $205,044.

BELLEVUE, PA.—We are informed by William Martin, Chn. St. Com., that a general system of municipal improvements is under consideration, but the plans are not yet completed.

CONNELLSVILLE, PA.—The council has decided to call a special election to vote on the issue of bonds for $40,000 for paving the streets with brick. With this appropriation by the borough $120,000 worth of paving could be done.

ERIE, PA.—Bids will be received until April 6 for 1.08 miles of brick paving. The council has passed ordinances for 2.35 miles of additional brick paving, which will be advertised soon. About 4,180 lin. ft. of asphalt and 900 lin. ft. of Medina stone paving will also be laid this summer. Geo. Platt, Cy. Engr.

WASHINGTON, D. C.—The district commissioners will receive bids until April 20 for 2,250,000 vitrified paving brick.

ATLANTA, GA.—About $20,000 of additional paving has been ordered.

WYANDOTTE, MICH.—Contracts for about 20 miles of macadam roadway, to be constructed near this place, it is reported, have been awarded to the Michigan Stone & Supply Co., Detroit.

ALEXANDRIA, IND.—Several miles of streets will be macadamized during the coming summer. Brick paving and concrete sidewalks will also be constructed.

INDIANAPOLIS, IND.—Several additional streets are to be paved with brick, the work to commence as soon as possible.

CHICAGO, ILL.—The commissioner of public works has prepared a statement showing that 800 contracts for street improvements have been awarded. These contracts include the construction of 143,412 sq. yds. of asphalt pavement, at $2.60 per sq. yd., and 2,214,480 sq. yds. of cedar blocks, at $1.10 per sq. yd. It is estimated that from $10,000,000 to $15,000,000 will be collected by special assessment and expended this coming year in street improvements.

MATTOON, ILL.—The city clerk will receive bids until April 21 for about 40,000 sq. yds. of brick paving.

VENICE, ILL.—A contract for 1,000,000 paving brick has been awarded to Ryan & Burke, Alton.

BURLINGTON, IA.—We are informed by William Steyh, Cy. Engr., that contracts have been awarded for 55,165 sq. yds. of brick paving, 21,374 lin. ft. of lime and sandstone curbing, and 22,000 cu. yds. of grading, to cost $107,178.

OMAHA, NEB.—Bids are wanted for nearly 50 paving contracts, work to be done the coming season.

ELECTRICAL.

DALTON, N. H.—It is reported that the projectors of the proposed electric light and power plant have already secured subscriptions for $85,000 of the proposed $100,000 of capital stock. The plant, if established, will probably furnish light and heat for St. Johnsbury, Vt., as well as for its own immediate territory.

NORTH ATTLEBORO, MASS.—At the town meeting March 25, it was voted to instruct a committee to furnish for the town an electric light plant for street and commercial lighting, at a price not to exceed $50,000.

DELEVAN, N. Y.—The Delevan Electric Light Co. has been organized to put in an electric light plant; Pres., W. F. Persons; Treas., M. E. King; Supt. of Construction, J. A. Morrison, Philadelphia, Pa.

FRANKLINVILLE, N. Y.—John Lawrence, Silver Creek, has been engaged by the Franklinville Electric Light Co. to superintend the putting in of the plant. The company has already secured contracts for placing lights in about 50 private dwellings.

GLENS FALLS, N. Y.—H. R. Leavens and T. S. Coolidge are interested in the proposed dam referred to last week.

HAMBURG, N. Y.—At the village election March 21 the village board was authorized to contract for electric lights, by a vote of 92 to 32.

ASHTABULA, O.—The city council has repealed the ordinance for issuing bonds for $15,000 for public buildings, in order to make sure the carrying at the election next month of the proposition to issue $15,000 of bonds for enlarging the electric light plant.

HAWARDEN, IA.—The city council has arranged with an electric light company to supply light for both public and private purposes, and the plant will be put in soon.

HARRISONVILLE, MO.—We are informed by A. J. Sharp, Mech. Engr., that plans will soon be prepared for a plant for 50 arc and 600 incandescent lights. Bonds for $12,000 have been voted, as noted in our issue of March 16.

CONTRACT PRICES.

PIPE AND VALVES.—Halifax, N. S.—We are informed by F. W. W. Doane, Cy. Engr., that the contract for cast iron water pipe and specials has been awarded to D. Y. Stewart & Co., Glasgow, Scotland, at $32.05 and $56.10 per ton (of 2,000 lbs.), respectively, all joints to be turned and bored. The contract for valves was awarded to Glenfield & Co., Kilmarnock, Scotland, as follows: 27-in., $250.29 each; 24-in., $199.26; 20-in., $114.82; 15-in., $58.38; 12-in., $37.66; 9-in., $23.81; 6-in., $13.12; total, $2,275.50. The other total bids for valves ranged from $2,616.40 to $3,064.50. There is a duty of $12 per ton on imported pipe.

BRICK PAVING.—Knoxville, Tenn.—The lowest bid for 50,000 sq. yds. of brick paving was that of M. J. Condon & Co., Knoxville, at $2 per sq. yd. The highest bid was $2.45.

MISCELLANEOUS.

CONCRETE PLANT AND DOCK.—New York, N. Y.—The contract for a concrete plant and dock at Fort Hamilton has been awarded to Mairs & Lewis, 18 Broadway.

GARBAGE DISPOSAL.—Buffalo, N. Y.—The contract for garbage disposal has been awarded to the Baynes Garbage Crematory Works, at $175,000 for five years. The bids were published last week.

Dayton, Ky.—The city council will receive bids until April 3 for the disposal of the city garbage.

JAIL.—Moab, Utah.—The clerk of Grand county will receive bids until April 13 for a county jail with a steel cell.

Eldora, Ia.—The auditor of Hardin county will receive bids until April 10 for a county jail; separate bids to be received for the building, and for the steel cells and ironwork.

DOCKS.—Buffalo, N. Y.—Engineers F. G & G. R. Sykes have been engaged for some time making surveys for the proposed docks in South Buffalo. It is claimed that about $3,000,000 has already been subscribed, and that the Buffalo Dock & Harbor Co. will be incorporated within a few days with a capital of $10,000,000. The slips will be 200 ft. wide and 20 ft. deep, and several of them are expected to be ready for use at the opening of navigation next year.

INDUSTRIAL NOTES.

LOCOMOTIVES.—The Pittsburg Locomotive Works, Pittsburg, Pa., have an order for 20 freight engines for the Duluth, Mesaba & Northern.—The Baldwin Locomotive Works, Philadelphia, Pa., have an order for 20 freight engines for the Missouri Pacific.—The Ohio Southern has ordered 8 mogul freight engines, 2 eight-wheel passenger engines and 2 six-wheel switching engines.—The Central of New Jersey has ordered 15 engines, 1 ten-wheel engine, 5 eight-wheel engines, 1 compound eight-wheel engine, and 5 switching engines.—The Boston & Maine has ordered 12 mogul engines, 12 eight-wheel engines, and 6 four-wheel switching engines.—The Rogers Locomotive Works, Paterson, N. J., have an order for 13 engines for the Wilkes-Barre & Eastern.

CARS.—The Michigan Peninsula Car Co., Detroit, Mich., has an order for 500 box cars, with Fox-pressed steel trucks, for the New York Central.—The Gilbert Car Mfg. Co., Troy, N. Y., has delivered 4 passenger cars to the New York Central.—Murray & Dougal, Milton, Pa., have an order for 500 freight cars for the Wilkes-Barre & Eastern.—The Pullman Palace Car Co., Chicago, Ill., has an order for 800 box cars for the Ohio & Mississippi.—The Litchfield Car & Machine Co., Litchfield, Ill., is building a fish transportation car for the Michigan Fish Commission, to be exhibited at the World's Columbian Exposition.—The Chesapeake & Ohio will add 8 Wagner sleepers to its equipment this year.—The Cincinnati, New Orleans & Texas Pacific is receiving 700 box cars.—The New York, Susquehanna & Western has ordered 1,200 hopper coal cars.—The Victor Stock Car Co., has been organized at Chicago, to operate cars for the transportation of live stock; capital stock, $100,000; incorporators, J. L. McKittrick, E. D. Northam, and R. J. Campbell.

CREOSOTING WORKS.—Ricker, Lee & Co., Galveston, Tex., have nearly completed the new plant, which will cost $30,000. The cylinder will be 100 ft. long by 9 ft. diameter, and the oil tanks will have a capacity of 1,600 barrels. At present, pine blocks for paving are being treated, and in the absence of a cylinder are steeped for 24 hours in a tank, the oil being heated by steam for the first twelve hours. The new plant will be completed about April 15. The creosoting plant of the Galveston Wharf Co. was burned in October last, as noted in our issue of Oct. 27, 1892.

COMMONWEALTH OF MASSACHUSETTS METROPOLITAN SEWERAGE COMMISSIONERS—NOTICE TO CONTRACTORS.—Sealed bids for the pumping plant for the Metropolitan Sewerage pumping station at East Boston, and sealed bids for the pumping plant for the Metropolitan sewerage station at Deer Island, will be received by the Board of Metropolitan Sewerage Commissioners at its office, 110 Boylston Street, Boston, Mass., until 12 o'clock m. of Saturday, May 27, 1893, and at that time will be publicly opened and read.

The Board will provide at each pumping station, an engine house, boiler house, chimney and masonry foundations for the pumps. The contractor's bid for each plant must be for furnishing, setting up, and completing, ready for use, two pumping engines (or sets of engines), four boilers, piping and all necessary appliances and fittings such as are to be found in pumping stations of the best class.

Each pumping engine must be capable of easily raising 70 cubic feet of sewage per second 19 feet vertically above the level of the sewage in its respective pump-well. Each of the engines must also be capable of raising to greater lifts up to 25 ft. quantities of sewage inversely proportional to such lifts.

The foregoing capacities must be demonstrated by suitable trials.

Each bidder must state in his bid the duty he will guarantee for each engine in the duty trial mentioned in the table below:

Table of Some of the Working and Trial Data, Etc.

	Deer Island.	East Boston.
Elevation of the surface of the sewage in the pump-well above datum....	Feet. (Varies from (to	Feet. 94.0 101.4	Feet. 90.8 93.2
Elevation of the bottom of the pump-well is assumed to be..	90.0	85.8
Elevation of the surface of the sewage in the discharge channel above datum.	(Varies from (to	101.0 *120.0	105.3 112.5
Least lift.....	7.0	14.5
Average lift.....	11.0	15.0
Ordinary maximum lift.....	18.6	19.3
Extreme lift at high spring tide and during rare storms.....	20 to 25	20.0
Lift during duty trial at rate of 70 cu. ft. per sec.....	11.0	15.0
Lift during capacity trial at rate of 70 cu. ft. per sec...	19.0	19.0
The elevation of the boiler house floor should be not lower than.....	116.5	116.5

* This elevation is for mean high tide. During spring tides and storms it will be higher.

The elevations mentioned above are referred to a datum about 100 64-100 feet below mean low water of Boston Harbor.

The contractors must provide at each station four steam boilers of such capacity that any three of them can easily supply the necessary steam for the two engines when discharging together 140 cubic feet per second with a lift of 19 feet.

Sketches will be furnished by the Board showing the position of the engine houses and the in-coming and out-going sewers at East Boston and Deer Island.

The first pumping engine at each station, and at least two boilers at each station, must be set up, ready to run, before May 31, 1894; the remaining engine, boilers and other appliances before Aug. 31, 1894. A third pumping engine and additional boilers will probably be called for at each station within a few months thereafter, and a fourth engine and additional boilers may be needed in the future. The third and fourth engines and their boilers are not now to be bid for. The arrangement of the plant, however, must be such as will not interfere with the above named extension.

The design of the pumping engines may be of any form which will fulfill the required conditions.

Each bid must be accompanied by drawings showing clearly the size and arrangement of the steam cylinders, pumps, boilers and all other parts of the mechanism and must also show the necessary details for the engine foundations, which are to be provided by the Board.

The specifications, which must also accompany the bid, must give the kind and the quality of the materials of which the various parts are to be composed, the size and the strength of the principal working parts, and the manner in which they are to be constructed, so as to furnish a clear understanding of all points regarding the workmanship, strength, durability, general efficiency of and space occupied by the whole mechanism and plant.

Each bid must be inclosed in a sealed envelope indorsed "Proposal for Pumping Plant for the Metropolitan Sewerage Pumping Station at East Boston" or "Proposal for the Pumping Plant for the Metropolitan Sewerage Pumping Station at Deer Island," and be delivered to the Board or to its clerk.

Each bid must be made on one of the blank forms furnished by the Board, and must be accompanied by a properly certified check for the sum of $1,000, the latter to be returned unless forfeited by the abandoning of the proposal.

The Board reserves the right to reject any and all bids.

Blank forms, general specifications and further information may be obtained at this office.

HOSEA KINGMAN,
TILLY HAYNES,
HARVEY N. COLLISON,
Board of Metropolitan Sewerage Commissioners of Massachusetts.
HOWARD A. CARSON,
Chief Engineer. 13-9t